METHODS OF STUDYING CONTROLLED WORD ASSOCIATIONS

BY

MILDRED WEST LORING

A DISSERTATION

Submitted to the Board of University Studies of the Johns Hopkins University in conformity with the requirements for the degree of Doctor of Philosophy
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METHODS OF STUDYING CONTROLLED WORD ASSOCIATIONS

MILDRED WEST LORING

From the Psychological Laboratory of the Johns Hopkins University

[The work reported here by Dr. Loring supplies the necessary ground for a series of investigations in which it is proposed to use the association method, and especially the method of controlled associative recall for the study of psychobiological problems. In addition to the data presented in this paper, Dr. Loring has accumulated a magazine of 10,888 words which have been selected on an experimental basis and classified, and from which future selections for any desired type of work may be made with great efficiency. Such a comprehensive list is essential if working lists are to be selected in scientific way, avoiding the associative sequences and preferences of the compiler. In accumulating and testing this list a labor of considerable magnitude has been performed, by methods which can scarcely be improved upon.

The experimental work reported was done in the light of a comprehensive survey of the literature of the association reaction from Francis Galton's in 1879 to authors of 1916, in which year the paper was completed. The historical survey and word lists are omitted from present publication, but the bibliography is included.]

Early in the history of the word association method it was observed that this method had distinct possibilities for practical application, especially in pathological fields, both because of its simplicity and because of its intrinsic diagnostic character. Very soon it began to be applied to the insane, the feeble-minded, and the delinquent with the hope that different types of association could be determined for each of these and their subgroups, and so provide one more aid to a critical diagnosis. The method was later used with great success in the detection of guilty knowledge. And with normal subjects there has been some study of the effect

of age, sex, environment and the like on the character of the associations, and lengthy efforts on the part of many authors to find satisfying classifications of the associations. But it will be noted though that comparatively little investigation has been done where the chief end in view was an examination into the actual technic of the method. The work of some of the earlier German investigators, it is true, does show considerable effort to regulate the length and type of stimulus words, but many have neglected these factors entirely. Many, too, have been content to use the stop watch to measure reaction time, and it may be for this reason that important variations in reaction time with different types of stimulus words and controls have been overlooked, inasmuch as the watch method introduces into the total reaction time three reaction times instead of one. The unreliability of the Hipp chronoscope without considerable modification and standardization, and its operating difficulties, doubtless caused many to abandon a careful determination of the reaction time.

A second fact which the history of the word association method discloses is that most of the conclusions have been drawn from free associations. In some of the early work continuous associations were studied but the obvious disadvantages of this method prevented its extended use. The controlled word association method, on the other hand, has had little investigation, except by some of the German investigators, probably because of the prevalent opinion that free associations represent more truly the natural course of ideas in the individual. And yet the controlled word association method has an advantage worthy of consideration. Because the free association method leads necessarily to a heterogeneous mixture of types of response, nearly every investigator has been forced to expend a great deal of effort in classifying the responses. Nevertheless they have reached no uniformity in their classifications. This difficulty is avoided in the controlled word association method, where the stimulus words are uniform, and the response words by virtue of the instruction to the subject are likewise uniform, so that the problem of classification is obviated.

The purpose of this investigation then was to consider the following points in the procedure of the controlled word association method, to determine to what extent these factors must be taken into account in a precise use of this method.

1. Does the length of the reaction time in controlled associations differ for the normal and inverse order of nouns and adjectives in the English language? That is, will the reaction time be longer or shorter when the stimulus words are adjectives to be responded to with nouns, than for the opposite, when the stimulus words are nouns to be responded to with adjectives? Is there any such relation between the verb-object and the verb-subject associations?

2. Does the length of the reaction time vary systematically, if the stimulus words are nouns and the response words are adjectives, according to the logical categories in which these nouns fall?

3. Does the length of the reaction time vary according to the number of syllables in the stimulus word, for the adjective-noun, noun-adjective, verb-object, and verb-subject associations?

4. Does the length of the reaction time vary according to the position of the accent in the stimulus word for the adjective-noun and noun-adjective associations?

5. If the same lists of adjectives and noun stimulus words are given for three successive days, requiring noun and adjective reactions, respectively, and with no additional instruction, will there be a systematic change in the reaction time from day to day?

6. Is there any variation in the length of the reaction time for normal and inverse directions of controlled double associations? If the stimulus word is an adjective, for an association to be made first to a noun (not spoken) and then to a verb as response word with this noun as its subject, will the reaction time be longer or shorter than when the control is reversed and the stimulus word is a verb to associate back through a noun subject to an adjective modifying this subject?

A consideration of these questions will indicate whether such factors are important in a precise use of the controlled word association method. Without any apparent knowledge of their rôle many investigators have drawn conclusions from variations

in reaction time which might well be within the normal limits of variation for the kind of stimulus word used, the length of the word, the position of its accent, and the type of control required.

APPARATUS

The Johns Hopkins chronoscope, designed by Dr. Dunlap, was used in this experiment to record the reaction times, and in connection with it Dunlap voice keys of the small model (97). The auditory method of presentation was employed, both stimulus and response words being spoken. The chronoscope is essentially a synchronous motor driven by a 50 D. V. tuning fork. The motor has 10 poles so that the armature rotates five times per second. Attached to the shaft of the armature is an electromagnet which rotates with the shaft; anterior to this magnet is a fixed magnet facing the rotating one. A light soft iron disc lies between the two magnets, attached at its center to a light shaft perpendicular to it which passes through a brass bearing to the anterior face of the clock, where it is attached to the index-hand. This sliding shaft moves back and forth according as the iron disc is attracted to the rotating or fixed magnet. When the master key of the voice key circuit (140) is closed, current flows first through the fixed magnet, which is in the branch of the circuit of the stimulus voice key, causing the disc to be attracted to this magnet, and then also through the rotating magnet. Since the current through both magnets is equal, the disc remains in the initial position. Speaking into the stimulus voice key breaks the current through the fixed magnet so that the disc is attracted to the rotating magnet. It then rotates with the armature shaft, causing the hand of the clock to turn at the rate of the armature, 5 rotations per second. Speaking into the reaction voice key breaks the current through the rotating magnet so that the disc jumps back again to the fixed magnet, and the hand stops. A spur gear on the shaft of the index-hand meshes with a larger cogwheel on the dial, serving as a rotation-counter. The dial itself is divided into 100 units, so that each unit measures 2 sigma. In using the chronoscope it is only necessary to set the hand at zero, press the master key before speaking the stimulus word.

keep it down until after the response word is spoken, and then read the reaction time directly.

The superiority of this chronoscope lies in the fact that it has no significant error, is extremely simple in operation, and runs continuously and noiselessly. It can run neither slow nor fast by the smallest fraction of time, else the motor gets out of step with the fork and stops. The only possible elements of error lie in (a) a possible change of vibration rate of the fork due to temperature changes, which can be obviated by enclosing it in a box with a thermostat, but which for this work is a negligible factor, (b) a possible error in the divisions of the dial, and (c) in a possible difference in reluctance of the disc between the magnets, in passing in opposite directions, due to a possible difference in the strength of the two fields. This last was found to be negligible in the chronoscope used.

The chronoscope will run continuously if care is taken to keep the fork contact properly adjusted. By experimenting, platinum wire was found impracticable for this; it burns up too quickly and has not enough spring to give the optimum length of period of contact for the motor to "catch." A gold alloy wire was tried, the wire used in dental work, and found extremely satisfactory. The gauge of the wire and its length are important, but these two factors must be determined empirically. As the wire burns back, the contact must be readjusted to keep the optimum period of contact for the motor. Only when this fails does the motor stop. Adjusting and cleaning the contact about twice a day when it is being used continuously all day has usually been found sufficient. The motor was run on the following voltage and amperage:

Voltage: 10.0 volts, closed fork contract, but not vibrating.

Voltage: 30.0 volts, broken fork contact.

Voltage: 25.4 volts, fork running on optimum contact for motor; motor dead.

Voltage: 25.4 volts, fork running, motor running.

Amperage: 1.3 amperes, closed fork contact, but not vibrating.

Amperage: 0.3 amperes, fork running on optimum contact for motor; motor dead.

Amperage: 0.3 amperes, fork running, motor running.

The motor is started by hand. It is equipped with a stroboscope if a higher rate is required, but for the low rate of 5 rotations per second a slight twist of the axle which soon gets to be a knack causes the motor to get in step with the fork.

The experimenter and subject sat on opposite sides of a small table with a large black curtain stretched between so that the subject could see neither the experimenter nor any of the apparatus. The experimenter sat with the master key and the chronoscope on his right and the fork on his left, each on separate stands, so that neither could affect the voice keys, which are so sensitive that the passing wagons or a moving chair in an adjacent room stops the clock. With this arrangement too, the experimenter could record results and regulate the fork contact without moving from his chair. The subject was given his instructions in regard to the type of response required and then the list of words. The experimenter signalled the subject before each word by saying "ready." Since the motor was practically noiseless, the only possible distracting noise was the low hum of the fork, which might have been eliminated by enclosing it in a padded box, or placing it in another room. This was a constant, however, throughout the experiment and apparently was not noticed to any appreciable extent except by one subject who worked at night when the building was absolutely quiet and all outside noises were at a minimum.

EXPERIMENT I

The general plan of the whole problem was to secure a large number of stimulus words—nouns, adjectives and verbs—to be given to a group of subjects, in order first of all that eliminations might be made of unsuitable stimulus words on the basis of the reactions to them. This was called experiment I. Final conclusions were not to be based on these results because the subjects were few in number and also because the lists of stimulus words contained many words unfitted for the association experiment. The primary object then was to detect these unsuitable words by means of the reaction time and the response word, and to omit

them in a later experiment. In experiment II these revised lists were given to a new group of subjects to make possible a more careful examination into the problems of technic under consideration.

To this end a complete survey of an abridged Standard Dictionary of 300,000 words was made and all one, two, and three syllable adjectives, nouns, and verbs (transitive and intransitive separately) were listed. A verb having both a v.t. and v.i. meaning was classed as v.t., so that the two verb lists comprised verbs which, respectively, can take objects and which cannot. A large number of all these words were necessarily omitted. These fell into three classes, (a) *technical words*, such as *modulus, titrates*, (b) *unfamiliar and archaic words*, such as *moil, bosky*, (c) obviously *vulgar words*. In this last list are included only such words as actually occur in the dictionary, and not words having their vulgar meaning only in a subtle and secondary sense. Separate consideration of these was made later. This made twelve lists, which altogether totaled 10,888 words, with the words of each in alphabetical order. To get them in random order, each list was cut up so that one word was on each slip. The words of each list separately were put in a box, shaken thoroughly and drawn out one by one for relisting into groups of 40 words each. When the words were in final form there were found to be the following number in each class.

	ADJECTIVES	NOUNS	VERBS (TR.)	VERBS (INTR.)
1 syllable.....	262	1806	792	219
2 syllable.....	973	2643	1028	231
3 syllable.....	791	1726	365	52
Totals.....	2026	6175	2185	502

These in groups of 40 each, were now ready for use. Two groups of subjects were chosen, one to work on adjectives and nouns, the other on both classes of verbs. The associations were controlled as follows,

STIMULUS	RESPONSE
Adjectives	Nouns
Nouns	Adjectives
Verbs (tr.)	Nouns (objects)
Verbs (intr.)	Nouns (subjects)

As the words at this time were not yet completely catalogued, the several groups of words were given in serial order, the adjective-noun group of subjects going through the whole series of adjectives, in the successive order of one, two, and three syllables, and on their completion going through the whole series of nouns in the same way. The verb group likewise first did the transitive verbs and then the intransitive verbs. As noted above, the various classes of stimulus words were in lists of 40 each in this preliminary work, and four lists were given per hour on a twelve minute schedule—that is, twelve minutes were allowed to a list, any time left over being given up to a rest period, during which the subject was allowed to do anything he pleased, converse with the experimenter, walk around or sit quietly. It was usually spent in irrelevant conversation. The remainder of the hour was allowed for preparation of material, breakdown of apparatus, and other details. Each day 160 words were given. In this experiment all subjects worked one hour per day for three days each week, as far as possible at the same hour of the day. The one exception was subject I who reported only twice a week. He fell far behind the others of his group, and for this reason subject IV was secured to supplement his work. It will be observed therefore that the results of these two are not capable of intra-comparison to the extent of the others; subject I finished all adjectives, part of the one syllable nouns, and all the two syllable nouns; subject IV did part of the one syllable nouns, and all the two and three syllable nouns.

Subjects were instructed as to the required type of response word, and told to speak the first word occurring to them that fitted this requirement as quickly as possible, even though the response word was not exactly precise. Subjects were frequently reminded

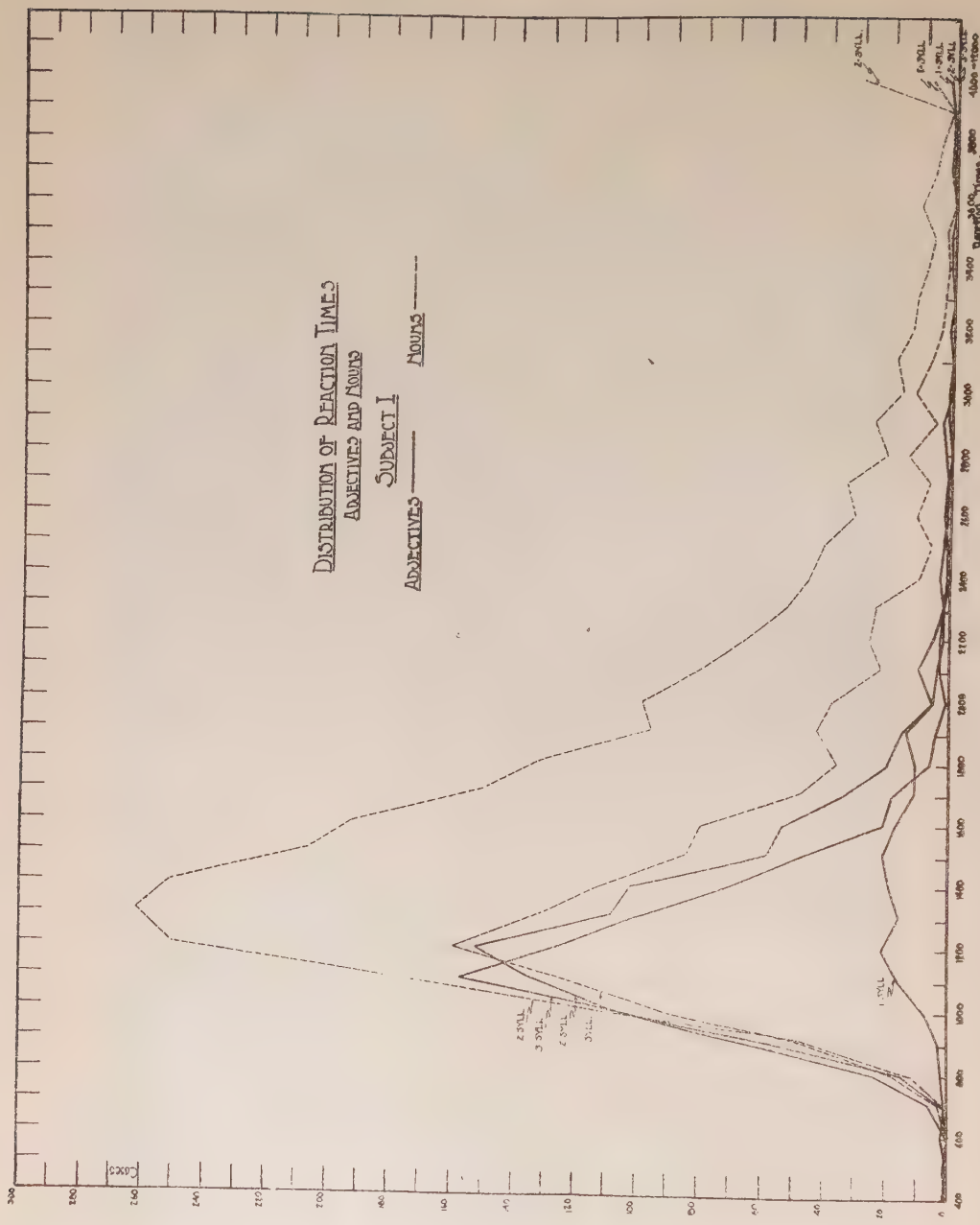
not to inhibit reactions that they might think foolish or vulgar; that the emphasis in this experiment was being put on the reaction time, not the reaction word, so they must feel free to react without inhibition. As thorough a spirit of informality as possible outside the working period was encouraged. All reaction times over twelve seconds were rejected arbitrarily as failures. The results for adjectives and nouns will be considered first, the results for verbs later, as the former were investigated in greater detail than were the verbs.

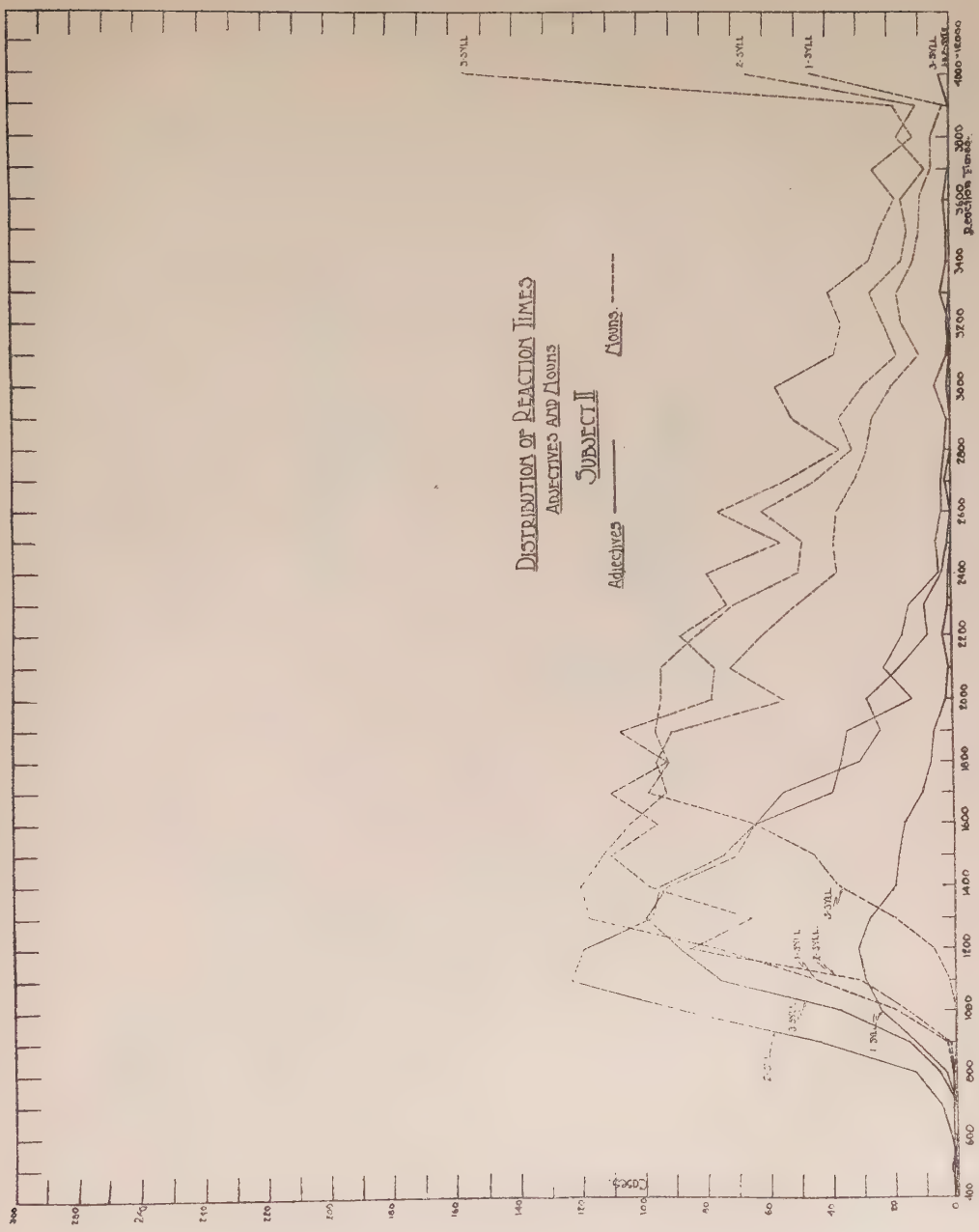
Four subjects were used in the adjective-noun experiment, to give three complete sets of reactions for all the adjectives and nouns. All the adjectives were completed by each of subjects I, II, and III, three syllable nouns by subjects II, III, and IV, two syllable nouns completely by subjects I and IV, about half each by subjects II and III, one syllable nouns completely by subjects II and III, almost all by subject I and the rest by subject IV. The exact relation of the numbers of words done by each will be seen in the number of cases given in tables 1, 2, 3, 4, 5, 6, 7, remembering that these figures represent the number of successful responses, not the entire number of stimulus words given to the subject. Subjects I, II, and IV were men students, a Senior, a Sophomore and a graduate respectively. Subject III was a woman graduate in the Department of Psychology.

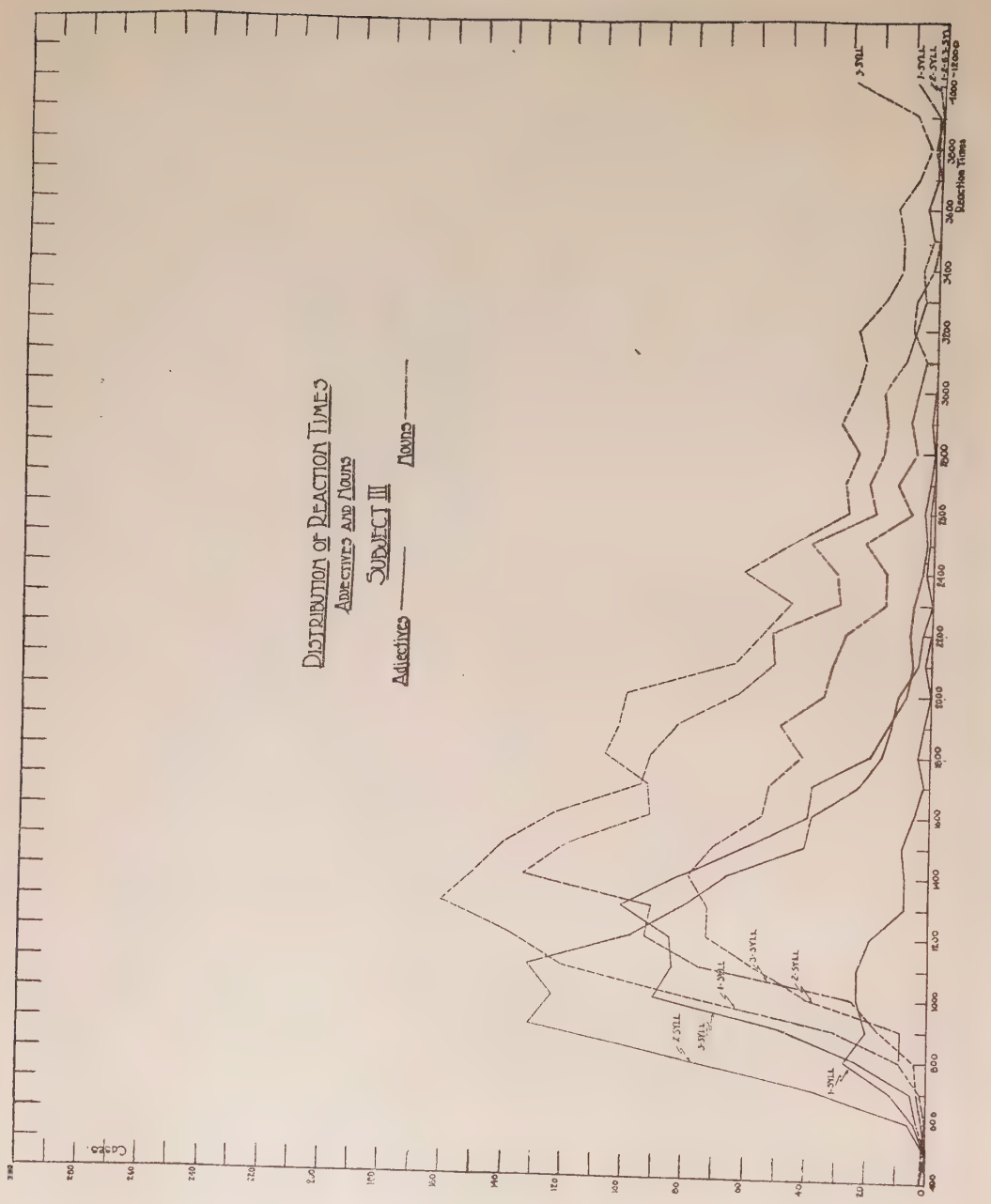
Results for the adjective-noun and noun-adjective association

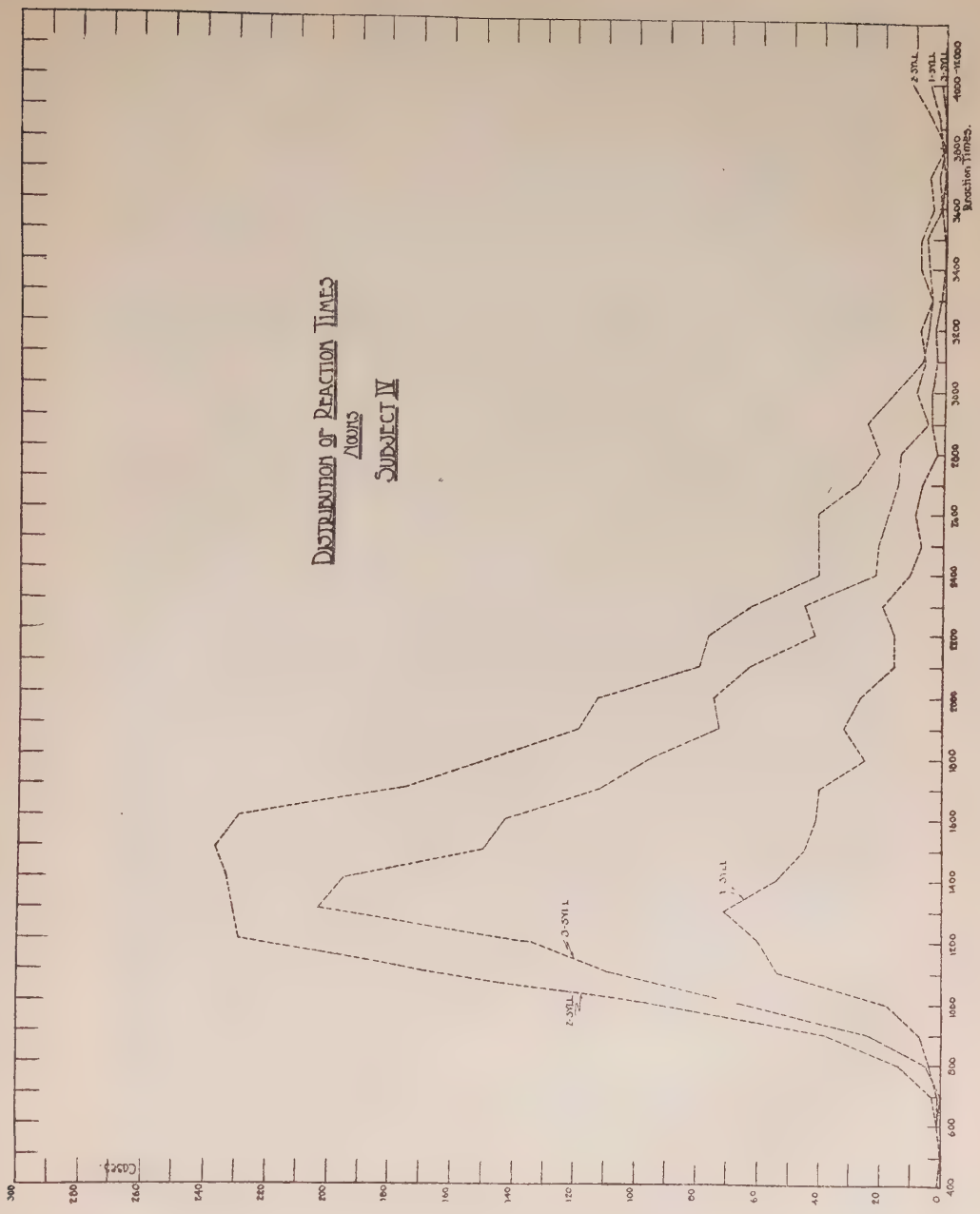
The results for adjectives and nouns in experiment I are shown in tables 1, 2, 3, 4, and 5, and in figures 1, 2, 3, and 4.

Table 1. Here are shown the number of cases, the average reaction times, and the mean variations for each of the six groups of stimulus words, one, two, and three syllable stimulus adjectives and nouns, for each of four subjects. There are no results on three syllable nouns for subject I nor on any adjectives for subject IV. The order in which these words were given is to be kept in mind. This was serially through one, two, and three syllable adjectives, and the nouns then in the same way. For subjects II and III the results are uniform. There is a definite


DISTRIBUTION OF REACTION TIMES
ADJECTIVES AND NOUNS
SUBJECT I
ADJECTIVES ——— NOUNS ———
Cases
Reaction Times


DISTRIBUTION OF REACTION TIMES
ADJECTIVES AND NOUNS
SUBJECT II
Adjectives
Nouns
3-SYLL.
2-SYLL.
1-SYLL.
EXCD.
Reaction Times.


DISTRIBUTION OF REACTION TIMES
ADJECTIVES AND NOUNS
SUBJECT III
Adjectives ——— Nouns ———
Reaction Times
1-SYLL.
2-SYLL.
3-SYLL.
4-SYLL.
5-SYLL.
1500-1800


Distribution of Reaction Times
Adults
Subject IV
Cases
Reaction Times.

increase in reaction time with the number of syllables for both nouns and adjectives, and a uniformly larger reaction time for any group of nouns over adjectives of the same number of syllables. For subject IV no conclusions can be drawn; the reaction time for nouns of one, two, and three syllables is practically constant. Since this subject did none of the adjectives no comparison is possible between the reaction times for adjectives and nouns. The vocabulary of subject IV was very wide; there were only two or three failures during the whole series due to unfamiliarity with the word. This may indicate that the increase in reaction time with the number of syllables is not dependent

TABLE 1

Reaction times for unselected adjectives and nouns (totals)*

SUBJECT	ONE SYLLABLE						TWO SYLLABLE						THREE SYLLABLE					
	Adjectives			Nouns			Adjectives			Nouns			Adjectives			Nouns		
	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.
I	164	1912	282	1190	1580	404	918	1324	240	2522	1744	470	749	1268	192			
II	211	1378	248	1461	2014	598	901	1396	284	1649	2210	630	755	1592	302	1581	2542	828
III	168	1138	218	1617	1730	442	907	1328	176	817	1750	414	728	1380	268	1608	2018	554
IV				591	1708	414				2527	1718	412				1674	1692	370

* Adjectives and nouns refer to the stimulus words in all tables.

on the actual increase in length of time for the stimulus word to be spoken, but rather because words increase in complexity of meaning and strangeness with their length. This would account for the increase in reaction time with the increase in the number of syllables for subjects II and III, and for the constancy in reaction time for subject IV whose interests were chiefly literary. The results for subject I are peculiar but thoroughly explainable. It will be noticed that for the adjectives, which were completed before the nouns were begun, there was a steady decrease in reaction time in progressing from one syllable to two syllables and then to three syllables, the averages being respectively 1912, 1324, and 1268 sigma. The

results for nouns, in regard to the increase in reaction time with increase in the number of syllables, agrees with those for subjects II and III. The reverse order for adjectives is to be explained by the fact that at the beginning of the work the subject was not in good health. This was not realized by the experimenter until the subject was well started in the work, and then it was thought interesting to see the effect of improvement in health on the reaction time. It will be observed how slow his reaction time is for one syllable adjectives as compared to the other subjects, and how much it dropped for the two syllable adjectives. It was in the middle of this group of words that his poor health, which manifested itself in extreme nervousness, suddenly improved after being treated by a physician. This continued throughout the remainder of the adjectives; it could hardly be said that his reactions were perfectly normal until this time, which was about a month later. From then on during the noun series there was nothing conspicuous in his behavior or reactions. Notes taken during his period of disturbance may prove of interest in emphasizing the dependence of the reverse order of reaction times upon his health at the time.

Subject I. November 18. A tendency today to respond to an adjective with a noun cognate to it, e.g., *awkward-awkwardness.* When questioned in regard to this, says he has a feeling of going along the line of least resistance, which he can not control. Went to see Dr. X. last Friday about his nervousness. Dr. X. gave him some bitter medicine and it made him better the next day, and he has felt better ever since. Subject I looks better and is much less nervous. Face not so scratched—scratches it when nervous. Has, he says, especially hard attacks twice a year. Has been playing heretofore during experiment with a collection of clamps, bars, wire, etc., collected from what is within his reach. No such behavior today.

November 19. Some tendency to react as on yesterday, e.g., *peevish, peevishness.* Some tendency to repeat the response of the previous stimulus word. Much repetition of *"being"* as reaction word. Nervousness present again today. Medicine taken last Friday was nux vomica—has been taking it every day, but not today, because "effect

wearing off." Now attributes his well-being of yesterday to the good weather, and vice versa for today which is cloudy.

November 26. Reactions of this type no longer occur: *awkward-awkwardness,* but new type has appeared—the same reaction word is given many times in the same list. *"Spirit"* was given 15 times in today's work (160 words). Other responses of this type were *"mean," money," "mood."*

December 2. Reaction types occurred like those of November 26. The repeated responses were,

List I—	Occasion	3 times
	Gift	3 times
	Condition	5 times
List II—	Occasion	2 times
	Gift	2 times
	Condition	1 time
List III—	Occasion	1 time
	Gift	5 times
	Condition	0 time
	Spirit	6 times

It may be that *"spirit"* in the last list was substitution, voluntary or involuntary, for the word *"condition."* In the middle of list III, subject said that when he gave a reaction that was being duplicated so often, it was not the word that first came to *mind,* but to his *lips,* i.e.,

Maternal—gift (spoken reaction)
Maternal—care (thought reaction)

After being told that hereafter on such reactions the *thought* word as well as the *spoken* word would be called for, these reactions began immediately to fall off, i.e.,

List IV—	Occasion	1 time
	Gift	0 time
	Condition	0 time
	Spirit	2 times
but	Mind	5 times

as if a new word were being introduced to avoid the anticipated questioning. There was still some evidence of the first type of odd reaction, i.e., *awkward—awkwardness.*

December 3. Duplicate responses continue.

List II—	Conduct	8 times
List III—	Conduct	1 time
	Spirit	5 times
	Action	5 times
List IV—	Conduct	2 times
	Spirit	4 times
	Action	2 times
	Condition	1 time
	Man	7 times
	Mind	5 times

Nouns—first day. Likes adjectives better than nouns; nouns call up an object with no particular emphasis on its qualities, while the adjective can not appear without an object. Subject feels that the nouns are going faster however.

Tables 2 and 3. These tables show the total distribution of reaction times for each of the four subjects who acted in the adjective noun experiment. The reaction time has been divided into steps of 100 sigma, and opposite each reaction time is recorded the number of cases for a particular group of words in which the reaction time had a value lying between this particular number of sigma and 100 sigma more. For instance, in table 2, subject I, there are 16 reaction times of values between 1100 and 1200 sigma, for one syllable adjectives. All reaction times greater than twelve seconds were arbitrarily discarded as failures, and since the number of cases of very long reaction times was few for most subjects, it was decided to bunch all cases of reaction times lying between 4000 and 12,000 sigma. This accounts for the number of cases listed opposite 4000 sigma sometimes being much greater than the adjacent number of cases.

These distribution tables bear out the results in table 1. On the whole for any given subject, the maximum number of cases for any group of nouns is at a higher reaction time than for adjectives of the same number of syllables. The syllable variation is not so perfect, but with greater uniformity among the number of cases, the modes would probably follow the averages.

These results have also been plotted into distribution curves, which are shown in figures 1, 2, 3, 4. In each figure are given

TABLE 2

Distribution of reaction times, adjectives and nouns

SIGMA	SUBJECT I						SUBJECT II					
	ONE SYLLABLE		TWO SYLLABLE		THREE SYLLABLE		ONE SYLLABLE		TWO SYLLABLE		THREE SYLLABLE	
	Adjectives	Nouns	Adjectives	Nouns	Adjectives	Nouns	Adjectives	Nouns	Adjectives	Nouns	Adjectives	Nouns
400	0	0	0	0	1		0	0	1	0	1	0
500	0	1	1	0	0		0	2	0	0	1	1
600	0	0	0	0	2		0	0	2	0	0	1
700	1	3	6	1	1		0	0	5	0	0	1
800	2	18	24	11	15		3	1	13	1	5	1
900	3	50	70	48	59		13	3	44	2	15	0
1000	7	91	108	113	108		24	19	87	16	37	0
1100	16	128	136	185	157		29	45	123	31	75	2
1200	21	159	152	250	126		31	76	119	85	88	7
1300	16	131	108	262	100		27	117	97	65	99	19
1400	19	112	102	251	71		19	120	94	98	92	37
1500	21	84	59	206	49		18	113	74	112	70	45
1600	17	80	54	192	21		16	104	64	95	64	64
1700	11	48	33	150	18		10	92	55	110	39	98
1800	11	36	20	132	6		7	95	30	91	36	92
1900	14	43	15	96	4		6	90	23	95	34	106
2000	5	38	5	99	1		2	54	28	93	13	77
2100	4	22	10	80	3		1	71	17	93	22	76
2200	2	26	5	66	3		3	61	8	82	16	87
2300	2	24	2	53	2		1	50	9	70	14	72
2400	3	10	1	46	0		1	37	3	49	4	79
2500	2	6	1	41	0		0	38	1	48	5	55
2600	1	11	2	31	0		0	37	0	61	3	75
2700	1	7	1	34	0		0	31	2	44	3	54
2800	2	14	0	21	0		0	27	0	32	2	36
2900	3	5	1	25	0		0	25	0	36	1	51
3000	0	12	1	16	0		0	19	1	28	5	56
3100	0	7	0	18	0		0	10	0	17	1	37
3200	0	4	1	13	0		0	16	1	21	0	35
3300	0	3	0	12	0		0	17	0	26	3	39
3400	1	2	0	9	0		0	12	0	16	1	26
3500	1	3	0	7	0		0	10	0	14	1	23
3600	0	0	0	11	0		0	10	0	16	2	18
3700	0	2	1	7	1		0	6	0	8	0	25
3800	0	1	0	5	0		0	6	0	17	0	12
3900	1	1	0	1	0		0	2	0	11	0	18
4000 to 12,000	2	8	0	30	0		0	45	0	66	3	156
Total cases	164	1190	918	2522	749		211	1461	901	1649	755	1581
Average R. T.	1912	1580	1324	1744	1268		1378	2014	1396	2210	1592	2542
M. V.	282	404	240	470	192		248	598	284	630	302	828

TABLE 3

Distribution of reaction times, adjectives and nouns

SIGMA	SUBJECT III						SUBJECT IV					
	ONE SYLLABLE		TWO SYLLABLE		THREE SYLLABLE		ONE SYLLABLE		TWO SYLLABLE		THREE SYLLABLE	
	Adjectives	Nouns	Adjectives	Nouns	Adjectives	Nouns	Adjectives	Nouns	Adjectives	Nouns	Adjectives	Nouns
400	0	2	1	0	0	0		0		1		0
500	0	1	0	0	0	0		0		0		0
600	4	0	6	0	3	1		1		1		1
700	12	2	36	2	5	3		1		3		0
800	27	9	82	9	23	4		4		14		5
900	20	31	131	9	48	16		7		38		24
1000	23	77	123	39	89	25		18		97		66
1100	23	120	131	57	83	74		54		169		109
1200	19	137	97	72	84	92		60		229		134
1300	8	160	80	72	100	90		71		231		203
1400	8	149	66	78	81	132		54		233		195
1500	9	139	41	70	60	118		45		237		150
1600	5	122	39	55	40	91		41		229		143
1700	2	94	23	53	39	92		40		175		112
1800	4	91	16	42	20	106		25		148		96
1900	2	82	13	49	14	101		32		119		73
2000	0	63	11	35	8	99		27		113		75
2100	2	51	4	32	6	64		16		80		63
2200	0	52	3	28	7	55		16		77		42
2300	0	30	0	15	6	46		20		63		46
2400	0	31	2	15	3	62		11		41		22
2500	0	40	1	22	2	46		7		41		21
2600	0	19	1	7	3	28		9		41		18
2700	0	21	0	12	1	29		7		28		15
2800	0	17	0	6	0	25		2		21		14
2900	0	16	0	8	3	31		4		25		5
3000	0	17	0	6	0	26		4		16		9
3100	0	10	0	3	0	23		2		7		6
3200	0	7	0	8	0	26		3		5		8
3300	0	4	0	7	0	17		1		4		4
3400	0	5	0	2	0	12		0		8		5
3500	0	2	0	0	0	12		0		8		6
3600	0	4	0	0	0	14		1		4		1
3700	0	1	0	0	0	7		0		5		2
3800	0	1	0	2	0	3		1		0		0
3900	0	1	0	0	0	9		2		5		0
4000 to 12,000	0	9	0	2	0	29		5		11		1
Total cases	168	1617	907	817	728	1608		591		2527		1674
Average R. T.	1138	1730	1328	1750	1380	2018		1708		1718		1692
M. V.	218	442	176	414	268	554		414		412		370

six curves, a one, two, and three syllable curve each for adjectives and nouns. Full lines represent the adjectives and dotted lines the nouns. The number of syllables is indicated on the curve itself. Smoother curves might have been obtained if larger steps in the reaction time had been chosen, and if the number of cases for the various groups of words had been more uniform. It is worth while emphasizing the fact that reaction times do not follow the error curve of mathematics. Whereas the error curve is perfectly symmetrical, the reaction time curve is very much skewed, with the maximum of the curve lying at a much lower value than the mean of the extreme reaction times. The reason for this is obvious. There is a physiological limit for the lowest value of a series of reaction times, below which no reaction time can fall, while on the other hand there is no such limit put upon high reaction times. Reaction times may be expected to be of any increasingly greater value beyond the minimum, up to infinity (which we call failure) depending on the ability of the subject. The curve then takes the form indicated here. It should be noticed therefore that only such mathematical formulae should be applied to the data of such curves as have been developed for this type of measurements. For this reason only the number of cases, averages and mean variations are given in the data presented here. There has been an unfortunate tendency to apply formulae that refer exclusively to the mathematical curve of error to such curves as are given here.

The reaction times may at first sight appear abnormally long. Likewise the mean variations may seem high. But this is not so however. In the first place no conclusion is valid unless based on a sufficiently large number of cases. In a great many investigations only a short list of words has been used and sweeping conclusions are made on the basis of their results. In this experiment over 8000 adjectives and nouns have been used for stimulus words, so that a fairer indication is given of the true nature of the reaction time under the conditions laid down in the experiment. In the second place no attempt has been made in this work to choose "easy" words for stimulus words. In much of the association work easy words have been chosen

because they are more suitable for educational and pathological tests. It is to be expected that the average reaction time on such a list of words given to normal subjects would be considerably lower than when the list of stimulus words is maximally inclusive as is the case here. The aim here was to retain as many words as possible both difficult and easy, rather than to choose a select, homogeneous list. But aside from these two reasons which might justify unduly long reaction times, it must still be concluded here that these reaction times are not long at all. A careful gleaning of the literature shows that where any considerable number of stimulus words has been used, reaction times running up to four and five seconds are not uncommon even for normal subjects. To what extent these high reaction times have been found is difficult to determine because in most cases detailed results are not given, and mean variations are invariably omitted which might afford a clue to this point. The chief interest has been concerning the nature of the associations themselves and this has helped to minimize a discussion of the length of the reaction time. For this reason detailed results are given here showing the number of cases, averages, mean variations, and distributions. All computations were made on the Burroughs electric adding machine. Mean variations were obtained with the Dunlap formula, which is especially adapted for use on a calculating machine.

Table 4. This table shows the variation in reaction time according to the position of the accent in three syllable adjectives and nouns. It was not considered worth while or valid to make comparisons on accent for two syllable words inasmuch as the percentage of these with the accent on the second syllable is extremely small in comparison with those having the accent on the first syllable. And likewise for three syllable adjectives and nouns, comparison is really valid only between words having the accent on the first and on the second syllable, inasmuch as the number of words with the accent on the third syllable is very small. No conclusion can be drawn at all in regard to the effect of accent on reaction time. The variations in reaction time with change of accent for either adjective or nouns follow

no consistent sequence for the various subjects. It is interesting to note though that with both groups of words here subdivided into three classes each, the conclusion drawn from table 1 still holds, that is, that the reaction time is greater for stimulus nouns than for stimulus adjectives.

Table 5. Here are shown the results of separating the stimulus nouns into seven logical categories and one unclassified group.

Considerable difficulty was experienced in finding a scheme for classification. It was intended at first to classify them into two groups only, abstract and concrete, but when an actual classification under these simple headings was tried it was found utterly

TABLE 4

Variation of reaction time with accent; three syllable unselected adjectives and nouns

SUBJECT	ACCENT ON FIRST SYLLABLE						ACCENT ON SECOND SYLLABLE						ACCENT ON THIRD SYLLABLE					
	Adjectives			Nouns			Adjectives			Nouns			Adjectives			Nouns		
	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.
I	363	1232	272				374	1294	198				12	1458	144			
II	368	1604	356	950	2508	768	371	1540	322	579	2594	700	16	1576	204	42	2674	586
III	352	1358	158	981	2034	558	365	1388	270	582	1992	286	11	1624	248	45	1948	566
IV				1014	1700	382				611	1686	368				49	1568	282

impossible. There is no hard and fast line between these two classes. There are, of course, nouns which are obviously concrete, and othere undeniably abstract, from a certain point of view, but between these and including a very large percentage of all nouns are a great horde which are really of widely varying degrees of concreteness and abstractness. The terms are only relative. From one point of view everything is concrete and from another everything is equally abstract. Even the stock illustrations of abstract nouns, such as *triangularity* or *virtue*, may be thought of as being just as concrete as *furniture* or *walking*. The words that gave the greatest difficulty were those of a lower level of abstractness than those which are usually used as illustrations of abstracts (nouns ending in *ity*, *hood*, *ness*),

TABLE 5

Reaction times for classified nouns (unselected)

	SUBJECT I			SUBJECT II			SUBJECT III			SUBJECT IV		
	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.
*One syllable group**												
In	554	1518	364	673	2022	544	725	1700	422	266	1708	452
An	144	1720	436	188	2198	804	212	1774	472	73	1656	400
Ac	152	1530	452	198	1964	526	216	1674	390	74	1730	408
Vg	34	1554	372	54	2078	648	63	1604	352	28	1594	372
Pb	46	1622	390	63	1782	410	63	1782	322	28	1610	410
Em	17	1630	268	18	2244	888	23	1774	496	6	2068	368
Ab	68	1654	380	78	2142	618	103	1900	622	52	1730	390
Un	175	1664	492	189	2238	574	212	1702	544	64	1776	364
Total	1190	1580	404	1461	2014	598	1617	1730	442	591	1708	414
*Two syllable group**												
In	1051	1644	396	659	2148	588	348	1702	414	1024	1666	418
An	541	1822	382	354	2282	612	169	1998	488	539	1698	384
Ac	248	1892	530	161	2264	624	88	1732	392	263	1826	436
Vg	78	1600	424	49	2080	376	28	1546	356	76	1606	440
Pb	37	1654	486	30	2290	558	8	1480	450	46	1696	320
Em	24	1990	558	16	2334	472	11	1758	264	23	1802	630
Ab	213	1836	552	186	2302	732	54	1664	396	246	1840	426
Un	312	1794	486	194	2198	678	111	1664	366	310	1768	440
Total	2522	1744	470	1649	2210	630	817	1750	414	2527	1718	412
*Three syllable group**												
In				434	2538	680	440	1956	524	446	1670	334
An				322	2716	682	325	2092	514	343	1674	356
Ac				222	2698	722	234	2060	648	236	1764	390
Vg				38	2338	704	42	1600	410	39	1404	268
Pb				12	2334	596	14	2540	536	20	1708	402
Em				23	2774	710	25	1750	518	26	1758	426
Ab				275	2864	614	279	2038	606	293	1702	420
Un				255	2656	694	249	2040	554	271	1694	414
Total				1581	2542	828	1608	2018	554	1674	1692	370

*In, inanimate objects; An, animate objects; Ac, nouns of action; Vg, vegetable kingdom; Pb, parts of body; Em, feelings and emotions; Ab, abstract nouns; Un, unclassified.

but which are not of the level of concreteness of *apple* or *book*. Such words are *cost, fate, style, skill.* Do we mean *costness, fatehood, styleness, skillness,* or the actual *money,* the actual *happening, short skirts and high boots,* and *manipulation of figures?* Or can we say that we are ever precise at all in just what we do mean, is now one meant, now the other? For this reason a new classification was sought. Seven categories with an additional unclassified group was the smallest number found possible to use. They were chosen as follows:

1. Inanimate objects. This class is self-explanatory.

2. Animate objects. Here are included all nouns denoting *living* objects in the animal kingdom. A *corpse* or a *salt herring* was classified as inanimate. The noun must also denote the whole organism, not just one of its parts, e.g *arm* and *knuckle* come under a later category.

3. Actions. These nouns express pure action, such as *leap, riding,* for their existence lasts only during the *leaping* or *riding.* After the *leap* has been *leaped* there is no *leap* left. This was taken as the test for this class. There are a good many nouns which may express either pure action or the result of the action. The adjective given by the subject was taken as criterion of which interpretation has been made by the subject, and it was so classified. If ambiguous, it was relegated to the unclassified group. Such an example of possible double meaning is the noun *crack.* This may mean the actual space in the side of the broken object, as in the reaction *jagged-crack,* or it may mean the action of cracking itself as in the reaction *sudden-crack.* The former and others of its kind were classified as inanimate objects.

4. Vegetable kingdom. This class is self-explanatory.

5. Parts of the body. This class is self-explanatory. It was of course not possible to list them under animate objects with words denoting a complete organism. Besides it was thought that a separate classification of these might through a possible increased reaction time throw some light on the emotional reaction, inasmuch as many parts of the body are of especial erotic significance.

6. Feeling and emotions. These are nouns actually denoting the feelings and emotion themselves, such as *love, anger, distress.* In this list were not included words having an emotional connotation, such as *mistletoe.*

7. Abstracts. These have been partly discussed above. It was decided to include not only the orthodox abstracts which usually end in *ity, hood, ness,* but also that lower hierarchy of abstracts including words like *vogue, needs,* and *loss.*

8. Unclassified. Here were put the days, months, seasons, sounds, diseases, weights and measures, collective nouns, directions of the compass, times of day, parts of speech, the sciences and arts, and others.

The result of this classification as indicated in table 5 shows nothing. There is no greater variation in the average reaction time for the eight classes of nouns for any given subject than would be expected from the large variation in the number of words per group. This of course was not controllable. This uniformity may indicate that emotional disturbances, from what ever cause—the meaning of the word, its relative unfamiliarity, etc.—do not necessarily manifest themselves in an increased reaction time but through some physiological mechanism other than the vocal apparatus, such as respiration, heart rate, blood pressure. This problem is already under investigation in this laboratory. Certainly nothing was indicated by this laborious classification to give any clue to a possible difference in types of response according to the intrinsic nature of the stimulus noun. Because of these negative findings it was decided not to compile reaction time results on the classification of adjectives. These adjectives had already been classified under the same heads as the nouns, the criterion of classification being the noun cognate with the adjective.

Results for the verb-object and verb-subject association

The results for verbs in experiment I, given in table 6 are analogous to those for adjectives and nouns. The reaction time for the verb-subject association is longer than for the verb-object

association, and the reaction time for both types of association increases directly with the number of syllables in the stimulus word. On the basis of these verb associations further eliminations in the verb stimulus words were made. It was only lack of time that prevented a more detailed investigation into these types of controlled associations by giving the selected words to a new and larger group of subject in a more systematic manner. This was done only with the selected adjectives and nouns.

TABLE 6

Reaction times for verb-object and verb-subject associations

SUBJECT	ONE SYLLABLE						TWO SYLLABLE						THREE SYLLABLE					
	Verb-object			Verb-subject			Verb-object			Verb-subject			Verb-object			Verb-subject		
	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.
V	435	1308	432	213	1536	506	985	1420	444	220	1898	598	369	1516	388	50	2124	438
VI	281	1708	606	194	1760	410	941	1756	544	219	1742	432				41	2118	542
VII	718	2026	808				960	2250	902				366	2490	926			
VIII	437	1614	520	195	2284	806				215	2690	906	351	2140	782	47	2990	1154

Conclusions for the adjective-noun and noun-adjective association

1. The reaction time for the noun-adjective association is very definitely longer than for the adjective-noun association, for stimulus words having the same number of syllables. The amount of this increase varies with the number of syllables in the groups compared and with the subject. The difference varied from 420 sigma to 950 sigma, but not in any fixed way in passing from words of one syllable to those of two and three syllables. The reason for this definitely longer reaction time for nouns than for adjectives is *probably* to be sought in the normal order of nouns and adjectives in the English language. With the exception of a few set phrases such as "durance vile" and "choir invisible" the universal order in the English language is adjective-noun. Because of this the habit of reaction in this direction is very stable and as mechanised as is possible with the permutation of adjectives and nouns occurring in language.

The reverse reaction therefore always requires greater effort and gives a longer reaction time. In connection with this possible explanation an experiment is under way in this laboratory to test out the same reactions on French, Italian, and Spanish subjects where the order of adjectives and nouns is on the whole the reverse from the English order. If this language explanation has validity, we will expect to find that the adjective-noun reaction is longer than the noun-adjective reaction.

A contributory reason for the reaction time being longer for nouns than for adjectives lies in the fact that many nouns are commonly never used with a modifying adjective, e.g., *rote* and *ounce,* and it is relatively difficult to find adjectives to modify them. This lengthens the reaction time. This was no factor however in Experiment II which follows, where all such words were eliminated. Subjects invariably stated that it is more difficult to respond with adjectives to noun stimulus words than with nouns to adjective stimulus words. They were questioned in regard to this and their naïve explanations all fell into this general scheme; an adjective always suggests some object having that quality, but a noun suggests no particular aspect of itself, making it necessary to "feel" for an attribute. Some notes taken of comments by different subjects may be of interest here.

Subject II. November 17 (first day on nouns). Nouns much harder than adjectives. Have to think backwards then forwards to see if adjective fits. Have to think harder but time seems to go much faster for a list. (This is not so—time really much longer.)

Subject I. December 10 (first day on nouns). Likes adjectives better than nouns, because nouns call up an object with no particular emphasis on its qualities, while the adjective can not appear without an object. It feels as if the nouns were going faster.

Subject IV. November 22 (first day on nouns). Felt as if doing poorly. Ought to be able to think of better adjectives—less commonplace ones.

2. The reaction time for these types of controlled associations increases directly with the number of syllables in the stimulus word. This holds for both adjectives and nouns. The one

exception found for adjectives was in the results for subject I and for nouns in the results for subject IV. These have already been explained. This increase varies for adjectives from 18 sigma to 196 sigma and for nouns from 10 sigma to 332 sigma.

3. The position of the accent in stimulus nouns and stimulus adjectives has no systematic effect on the reaction time.

4. There is no interpretable variation in reaction time according to a logical classification of the stimulus nouns for the noun-adjective association. The reaction time remains relatively constant within the limits of word length. The variations can be attributed to a difference in the number of cases in the various groups.

5. From observations of the subjects during the course of the experiments is to be concluded that two or three separate hours of work are sufficient for the subject to become adapted to the experiment, to lose any emotional disturbance due to sex difference between experimenter and subject, as far as this last can ever be reached. Inhibition of associations from such a cause we are persuaded was at its minimum during the whole experiment for all subjects.

6. It is impossible for a subject to keep at the top notch of tension throughout the whole of one session, and necessarily not for the whole experiment, to the same extent that this is possible in getting reaction times on a few words. That which we call "tension," whatever its physiological mechanism, was evident for the first two or three words of each list. It was indicated by a distinctly shorter reaction time and an observable muscular rigidity in the subject. The reaction time then suddenly became longer and remained more or less uniform throughout the list. It is probable that this later uniformity is due to an adjustment to a certain comfortable physiological tension that can be maintained through the course of one hour's work at a time, for three days a week, throughout several months.

Conclusions for the verb-object and verb-subject associations

1. The reaction time for the verb-subject association is longer on the average than for the verb-object association for stimulus words having the same number of syllables. This is *probably*

due to the word order in the English language. Since the normal sequence for subject, verb, object is seldom varied, it is natural that associations between them should be in the order of subject-verb and verb-object. If the reaction time should prove to be equal for these associations in their normal order, it would follow that by reversing one association, for instance the subject-verb to the verb-subject, this reaction time would be longer than for the verb-object association. This is what the results here show. It is probable therefore that the English word order accounts for the relative value of the reaction times for the verb-subject and verb-object associations.

2. For both types of verb associations the reaction time on the average increases directly with the number of syllables in the stimulus word. The explanation for this is probably the same as for the same finding for adjective-noun and the noun-adjective associations, that is, it is due to the increasing unfamiliarity and complexity of meaning of a word with the increase in the number of its syllables, rather than to the actual increase in the time taken to speak the longer words.

EXPERIMENT II

A more detailed study of the adjective-noun and noun-adjective association

From the results of the previous experiment it was possible to secure a revised list of adjectives, nouns, and verbs, forming a lexicon of words suitable to the types of associations outlined above; to take an equal number of each group for further trial on a large number of subjects and investigate in greater detail the same problems studied in experiment I. The lexicon was compiled for each of the four groups of words and will be later published separately but lack of time prevented any further investigation into the verb-subject and verb-object associations. The first task was to eliminate unsuitable words. These were found to fall into the following classes:

1. Unfamiliar words beyond those already eliminated in making up the original lists. Throughout experiment I there was a

growing conviction that it is necessary to distinguish between the reading and the conversational vocabulary. In making the original lists the experimenter had unwittingly but naturally chosen words which are familiar as *read*. Many of these were pronounced unfamiliar when heard by the subject, though his judgment changed when the word was spelled for him.

2. Words difficult to pronounce intelligibly to the subject, such as *leak*, which was taken variously as *leap*, *link*, etc.

3. Words having an emotional value either obviously or subtly; in the first case words like *pregnant*, *corset*, etc., and in the latter case that rather large group of words almost entirely confined to the masculine vocabulary whose dictionary meaning is perfectly unemotional, but in everyday use have also a subtle sexual meaning. The elimination of these words was made by several men in the department. Since however, many of these words seem to be purely colloquial, there are doubtless many still in the revised lists.

4. Homonyms in the narrow sense. A difference of spelling and identity of pronunciation in words of the same part of speech was made the criterion. *Fate* and *fete* are homonyms for this experiment, but not *great* and *grate*. It was considered sufficient control that the subject knew what part of speech he was being given. Furthermore most homonyms actually do exist in the narrow sense taken. Two of these homonyms escaped detection and got into the revised lists. These are *chaste, chased*, and *dessert, desert.'*

5. Words that are intrinsically difficult to respond to with the required type of response, such as the nouns *nothing* and *ounce*. Adjectives are not commonly used with these nouns.

6. A small group of words eliminated for various unclassified reasons, long reaction times or absurd responses attributable to none of the above reasons.

After these rejections were completed, special lists were made up from the selected words for ten days' work. Each list contained 30 words and six lists were given in an hour making 180 words per session. Whereas the two types of stimulus words were run through serially in experiment I, in this experiment one,

two, and three syllable nouns and adjectives were run in parallel so that comparison between the groups would be entirely valid. Therefore each day's series was made up of one list each of the following words and give in this order:

(1) One syllable adjectives
(2) One syllable nouns
(3) Two syllables adjectives
(4) Two syllable nouns
(5) Three syllable adjectives
(6) Three syllable nouns

The adjectives and nouns alternated on successive days in occupying the first position in the series. Nouns occurred first on odd days and adjectives on even days. It was discovered unfortunately that there were not enough selected one syllable adjectives to cover ten days' work, in fact there were only 194 of them, enough for six days' work (180) and a few over. For this reason it was possible to carry out the above procedure for only six of the ten days. The remaining days' work was made up only of two and three syllable adjectives and nouns. It was necessary to drop one syllable nouns for the remainder of the series in order that there might be an equal number of one syllable adjectives and nouns for the comparison of their reaction times. To make the number of two and three syllable adjectives and nouns come out even for the remaining four days' work the following schedule was adopted:

Days 7 and 9..... { Two lists each of 2 syllable nouns and adjectives
One list each of 3 syllable nouns and adjectives

Days 8 and 10..... { Two lists each of 3 syllable nouns and adjectives
One list each of 2 syllable nouns and adjectives

This gave the following distribution of the 1800 stimulus words:

1 syllable adjectives and nouns, each 180..... 360
2 and 3 syllable adjectives and nouns, each 360..... 1440

In addition to the regular ten days' work, three days' practise work was given beforehand on the basis of the conclusion in experiment I that the length of time required to become adapted

to the experimental situation is two or three sessions. For stimulus words, were taken whatever material was available from the rejected words of various kinds, and as nearly as possible the scheme of parallelism and alternation was carried out. No three syllable nouns were included in these practise words. Rejections had not been quite completed on them at the time experiment II began, inasmuch as the three syllable nouns formed the last material for experiment I. The actual three days' practise words, totalling 540 nouns and adjectives, were distributed as follows:

	ONE SYLLABLE	TWO SYLLABLE	THREE SYLLABLE
Adjectives	30	180	60
Nouns	120	150	0

It was also intended that the results for the practise period and the regular ten days' work should be compared to see directly the effect of excluding unsuitable words of different kinds.

Eight subjects were used in this experiment, four of whom had acted as subjects in the experiment on verbs, subjects V, VI, VII, VIII and four who were entirely new to the whole procedure. All eight subjects took the practise work, for there was no reason for thinking necessarily that the first four might be adapted to adjective and noun associations merely because they had been working on verb associations. Of course practically all emotional disturbance in the first four subjects had already been eliminated. At the beginning of the regular ten days' work it may be said that all subjects had lost as much of any emotional disturbance as they would ever lose, and for all except one subject perhaps we would say that any remaining emotional upset was practically nil. This one exception, subject XII, was of a naturally shy disposition. Subjects VII, VI, VIII, IX, X and XII were all university men, the first of these being a Ph.D., the second a graduate student, the next two sophomores and the last three freshmen. Subject XI was a junior at a woman's college. In all there were seven men and one woman. It had been hoped to have an equal number of men and women but the difficulty of getting women subjects prevented this.

Results for experiment II

Table 7. This is similar to table 1, experiment I. It shows the number of cases, averages, and mean variations for one, two, and three syllable selected adjectives and nouns for the total regular ten days' work. The results are consistent throughout for each observer in corroborating the conclusion in experiment I that the noun-adjective reaction is longer than the adjective-noun reaction. These results also substantiate the earlier conclusion that the reaction time increases directly with the number of syllables in the stimulus word for these two types of associations.

TABLE 7

Reaction times for selected adjectives and nouns, regular ten days' work (totals)

SUBJECT	ONE SYLLABLE						TWO SYLLABLE						THREE SYLLABLE					
	Adjectives			Nouns			Adjectives			Nouns			Adjectives			Nouns		
	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.
V	179	1196	236	176	1584	418	347	1382	278	352	1666	408	350	1616	450	348	1852	424
VI	176	1196	356	176	1602	386	351	1290	358	344	1836	598	352	1466	414	350	1910	580
VII	177	1640	478	177	2380	928	350	1856	636	346	2660	1014	351	2130	758	344	2902	1046
VIII	168	1766	548	169	2434	730	341	1962	652	334	2752	624	344	2318	920	347	2978	1042
IX	174	1738	634	172	1918	586	347	1830	604	337	2338	804	340	2022	612	349	2568	814
X	173	1338	300	174	1532	294	349	1508	240	334	1714	346	344	1790	546	340	1958	358
XI	174	1694	676	177	2300	886	350	1998	812	348	2860	1286	332	2396	1078	339	3002	1334
XII	172	1736	622	166	1920	562	343	2038	710	344	2336	798	332	2460	810	344	2518	840

Table 8. This table shows the reaction times for the regular ten days, giving the numbers of cases, average reaction times, and mean variations for each of the ten days separately. The conclusions drawn from the previous table, where, the same reaction times of each class were treated en masse for the ten days, are on the whole borne out here. An examination into the relative length of the average reaction time for adjective and noun stimulus words for each subject for each of the ten days shows the following number of cases where the noun stimulus word gives a longer average reaction time than the adjective stimulus word. Of course, only the average reaction times for the same

TABLE 8

Reaction times for selected adjectives and nouns regular ten days' work (by days)

SYLLABLES	DAY 1						DAY 2						DAY 3						DAY 4						DAY 5					
	Adjectives			Nouns			Adjectives			Nouns			Adjectives			Nouns			Adjectives			Nouns			Adjectives			Nouns		
	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.
Subject V																														
1	30	1190	206	28	1602	360	30	1146	154	30	1416	332	29	1206	140	29	1786	502	30	1130	256	29	1388	244	30	1288	286	30	1592	502
2	28	1174	150	29	1540	294	30	1326	278	30	1476	252	27	1336	202	29	1744	442	30	1318	270	29	1390	234	29	1420	192	30	1712	376
3	29	1348	252	30	1558	132	30	1528	298	30	1702	370	29	1538	344	28	1586	300	27	1618	506	29	1718	338	30	1350	242	29	1908	350
Subject VI																														
1	30	1158	288	28	1636	366	28	1086	168	30	1436	274	29	1376	310	29	1746	530	30	1214	236	30	1862	448	30	1108	212	30	1502	362
2	28	1278	256	30	1710	542	29	1266	236	27	2012	722	30	1838	598	29	2158	710	30	1186	442	29	1794	518	28	1184	284	29	2012	534
3	30	1540	440	28	2100	568	27	1648	464	30	1998	670	28	1528	358	30	2510	932	29	1548	300	30	1830	402	30	1422	412	29	2004	620
Subject VII																														
1	28	1742	524	29	2546	994	30	1568	524	30	2358	998	30	1682	452	30	2112	526	30	1372	346	30	2230	722	30	1890	560	29	3042	1154
2	28	1884	660	27	2664	1226	29	1920	598	30	2608	992	29	1918	590	29	2628	1208	29	1760	622	30	3002	1318	30	2102	490	30	2988	1412
3	28	1698	572	26	3234	964	28	1892	752	29	2416	632	30	1852	594	30	2918	852	29	2168	414	29	3196	1292	29	2650	1006	28	3602	1328
Subject VIII																														
1	25	2112	588	26	2458	576	27	2128	546	29	2840	732	27	1628	450	26	2476	836	30	1350	262	29	2280	804	30	1570	662	30	2250	646
2	27	2274	642	26	2624	664	28	2784	1108	30	3520	1484	27	2024	574	25	2238	690	29	2176	720	29	2594	830	28	1690	530	28	2848	1142
3	26	2660	828	27	3042	1126	26	2926	1238	29	3212	906	28	2390	670	29	2644	744	28	2358	738	30	2514	724	29	2102	788	28	2690	650
Subject IX																														
1	30	1972	638	30	2018	552	29	1560	442	29	1742	484	30	1406	362	29	2214	820	30	1634	662	26	1916	522	26	2010	876	29	1740	472
2	29	1698	572	29	2268	778	27	1914	664	26	2142	632	30	1720	636	28	2412	884	30	1440	394	28	2140	710	29	1946	702	27	2352	666
3	29	1972	480	28	2202	584	27	1818	480	28	2820	1218	28	1966	604	29	2684	722	28	2008	730	30	2370	640	28	2192	632	29	2590	660

Subject X

1	28	1472	384	27	1360	268	29	1324	332	28	1496	266	30	1232	218	30	1546	270	29	1192	210	29	1422	300	27	1441	170	30	1718	354
2	28	1522	508	27	1690	312	30	1616	390	28	1546	252	29	1482	348	29	1642	234	29	1384	318	28	1678	364	29	1572	196	26	1780	350
3	30	1626	418	28	1676	278	28	1682	376	29	1634	254	29	1658	372	29	1716	306	27	1738	308	29	1778	268	28	1942	344	26	2022	348

Subject XI

1	30	1656	586	29	2012	718	30	1872	812	29	2660	1110	29	1722	636	30	2436	814	27	1768	728	29	2520	1222	30	1656	638	30	2106	768
2	30	1836	696	30	3054	1480	30	1646	512	29	2920	1106	28	2664	1268	29	2682	1266	30	1766	592	29	2532	1046	28	2016	668	29	2604	1312
3	30	1824	748	27	2680	1204	28	2480	982	28	2850	1294	27	2650	946	27	2980	1536	27	2976	1790	30	2378	598	28	1828	670	30	2564	1018

Subject XII

1	30	1730	440	25	1930	428	29	1914	558	29	1660	464	26	1766	434	29	2078	668	28	1620	586	28	2394	704	30	1726	612	29	1876	374
2	30	1908	792	28	1958	554	27	1640	374	29	2038	760	26	2116	678	29	2642	1016	28	1982	720	27	2566	824	30	2162	938	29	2026	540
3	27	2136	494	29	2328	680	27	2138	620	30	2312	754	28	3256	1300	27	2902	782	28	2532	974	28	2504	764	26	2332	904	29	2482	638

TABLE 8—*Continued*

SYLLABLES	DAY 6						DAY 7						DAY 8						DAY 9						DAY 10					
	Adjectives			Nouns			Adjectives			Nouns			Adjectives			Nouns			Adjectives			Nouns			Adjectives			Nouns		
	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.
Subject V																														
1	30	1218	218	30	1666	454																								
2	30	1282	162	30	1854	640	59	1358	390	59	1640	392	29	1190	214	28	1554	286	56	1674	458	59	1994	502	29	1400	266	30	1758	346
3	30	1638	540	29	1738	326	28	1704	572	30	2038	618	58	1748	592	55	1748	268	29	1844	438	29	2212	534	60	1674	432	59	2046	484
Subject VI																														
1	29	1194	196	29	1370	246																								
2	29	1410	306	28	1884	614	58	1280	332	56	1944	596	30	1086	240	26	1412	466	59	1266	338	60	1704	464	30	1066	184	30	1708	482
3	29	1650	184	28	1896	516	30	1220	276	29	1540	324	59	1346	420	58	1660	510	30	1382	304	29	1780	308	60	1436	362	59	1916	592
Subject VII																														
1	29	1592	342	29	2014	526																								
2	29	2016	928	29	2426	738	60	1832	560	58	2544	768	30	1562	854	29	2644	1070	57	1832	546	55	2578	790	29	1884	420	29	2688	996
3	30	2142	754	30	2528	890	30	1938	550	28	2800	986	59	2316	710	60	2590	984	30	1946	668	29	2932	836	58	2154	754	55	2902	1226
Subject VIII																														
1	29	1604	520	29	2314	734																								
2	28	1946	750	28	3008	982	60	2080	678	55	2728	882	29	1396	380	26	2646	884	55	1860	518	57	2784	970	30	1350	318	30	2374	714
3	30	2440	914	29	3074	644	29	2414	940	30	3016	962	59	2216	740	59	2974	1024	30	2102	800	29	3004	928	59	2044	658	57	3106	1032
Subject IX																														
1	29	1816	636	29	1946	520																								
2	29	1642	404	30	2562	998	58	1750	596	57	2106	586	30	1554	406	25	2302	794	55	2166	794	57	2642	1104	30	1562	504	30	2210	840
3	30	2220	880	30	2782	902	27	2142	736	30	2212	480	57	2028	572	57	2712	966	30	2230	724	30	2756	824	56	1776	398	58	2518	736

Subject X

1	30	1384	312	30	1630	284		1458	314	57	1606	214	29	1456	376	26	1694	356	58	1484	284	57	1810	370	30	1644	368	28	1946	360
2	29	1540	481	28	1764	442	58	1690	348	29	1932	344	59	1810	474	59	2022	394	29	1604	344	28	1942	412	55	1956	516	55	2146	542
3	29	1852	416	28	1820	358	30																							

Subject XI

1	28	1558	590	30	2082	666		1766	712	58	2804	1376	28	1480	410	29	2238	896	60	2458	1104	56	3014	1562	29	1930	910	30	3698	1842
2	28	1692	572	29	2382	830	59	1934	624	30	2700	1168	52	2284	994	58	2850	1184	29	2234	630	26	3758	1826	56	2732	1356	53	3214	1320
3	29	2394	1216	30	3682	1988	28																							

Subject XII

1	29	1660	402	26	1640	394		1964	644	56	2404	802	29	1886	616	28	2552	842	59	2356	796	60	2568	886	30	1760	676	30	1998	738
2	25	1532	416	28	2246	678	59	2366	646	29	2568	742	56	2422	894	58	3058	1152	29	2984	1536	27	2638	1030	59	2086	708	58	2098	566
3	28	2242	622	29	2240	706	29																							

day are compared, and therefore the maximum number of cases following the rule for one syllable stimulus words is six and for two and three syllable stimulus words is ten.

TABLE A

Number of cases following the rule for the relation between the reaction times for adjective-noun and noun-adjective associations

SUBJECT	ONE SYLLABLE STIMULUS WORDS	TWO SYLLABLE STIMULUS WORDS	THREE SYLLABLE STIMULUS WORDS
V	6	10	10
VI	6	10	10
VII	6	10	10
VIII	6	10	10
IX	5	10	10
X	5	9	8
XI	6	10	9
XII	4	9	7
Totals	44	78	74
Maximum total	48	80	80

Likewise the conclusion drawn from experiment I and from the previous table of experiment II, concerning the variation in the average length of reaction time with the number of syllables in the stimulus word, is confirmed here, although not so thoroughly as is the previous conclusion. In most cases throughout the ten days the reaction time increases with the number of syllables in the stimulus word. This holds true for both adjectives and nouns. If on a given day adjectives of one, two, and three syllables are given, and if we are looking for a continuous increase in reaction time for one to two, and from two to three syllable words, there will be two steps in this increase, either of which may break down. On those days where only two and three syllable words were given there is only one step. Therefore according to the rule previously established there should be 16 successful increases in the reaction time for both adjectives and nouns, during the whole ten days' work. The following table shows to what extent the rule is substantiated when the results are taken by days.

TABLE B

Number of cases following the rule for increase in reaction time directly with the number of syllables

SUBJECT	ADJECTIVES	NOUNS
V	14	12
VI	13	13
VII	13	13
VIII	16	12
IX	11	15
X	16	15
XI	11	11
XII	14	15
Totals	108	106
Maximum totals	128	128

Table 9. Here are shown the results for the practise period. The same conclusions hold here as for the regular period; the reaction time for the noun-adjective association is longer than for the adjective-noun association, and the reaction time for both adjectives and nouns increases directly with the number of syllables in the stimulus word. There are two exceptions for adjectives, one for subject VII and one for subject X. It will be observed that all the averages for subject X compared with the others are relatively low. This was due to an actual narrowness of vocabulary, which instead of hampering him actually hastened his reaction. He was a university freshman from a preparatory school where little attention was given to English. As a result his reactions lay within a narrow range and duplicates were common. This was true particularly for the adjective responses to nouns. They were made up largely of what Kent and Rosanoff call non-specific reactions, such as *large, small, good, bad, tall, short,* etc. Few if any adjectives were of more subtle or connotative significance. Nouns that were reacted to by the other subjects with such adjectives as *horrible, ghastly* or *beautiful, wonderful* got merely *bad* or *good* from this subject for a response. Necessarily these stock adjectives occurred many times in one list and allowed of a relatively short reaction time. The noun responses were meager in their con-

notation and variety, though to a less degree than the adjectives. Owing to the dearth of words in his vocabulary a good many words of common knowledge were unknown to him and their reactions had to be recorded as failures. These reasons may account for the break in the results. For this subject as well as for all the others the reaction times for the rejected words of this practise series are much longer than for the selected words of the regular series.

TABLE 9

Reaction times for practise adjectives and nouns, preliminary three days' practise (totals)

SUBJECT	ONE SYLLABLE						TWO SYLLABLE						THREE SYLLABLE					
	Adjectives			Nouns			Adjectives			Nouns			Adjectives			Nouns		
	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.
V	29	1534	432	115	2072	588	174	1638	412	138	2082	572	55	1802	354			
VI	29	1316	336	103	2128	572	159	1774	618	131	2554	784	50	2118	662			
VII	28	1866	416	103	3720	1560	156	2620	1050	128	3776	1426	50	2538	988			
VIII	26	1938	532	97	3302	1060	157	2634	1030	124	3722	1332	45	3094	1040			
IX	27	1834	848	105	3186	1378	147	2638	840	114	3518	1462	47	3004	956			
X	23	1726	494	96	1750	448	149	1664	370	118	1968	508	49	1842	466			
XI	28	1636	522	94	3006	1146	154	2132	778	133	3168	1360	50	2456	1234			
XII	25	1704	556	98	2976	1204	155	2566	950	131	3720	1288	37	3128	944			

Table 10. This table shows the results by days for the practise period. There is only one case where the noun series gave a shorter reaction time than the adjective series. There are six exceptions however to the rule for syllable variation, three for adjectives and three for nouns.

Tables 11 to 14 (inclusive). These give respectively the distribution of reaction times for each of the eight subjects for the regular ten days' work, with the average reaction time, mean variation, and the total number of cases given at the foot of each column. It is to be noted that the difference between the actual number of cases recorded and the number of stimulus words given in each group (180 or 360) is due to various causes:

1. Failure to respond at all, or with a suitable word.
2. Stopping of the motor.

TABLE 10

Reaction times for practise adjectives and nouns, preliminary three days' practise (by days)

SYLLABLE	DAY 1						DAY 2						DAY 3					
	Adjectives			Nouns			Adjectives			Nouns			Adjectives			Nouns		
	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.
Subject V																		
1	29	1534	432	28	1878	680				29	2052	664				58	1120	572
2	58	1772	348	56	2164	620	57	1650	410	54	2012	504	59	1502	344	28	2052	400
3							25	1662	350				30	1920	370			
Subject VI																		
1	29	1316	336	25	1920	414				25	1830	402				53	2322	574
2	50	1720	550	48	2474	780	56	1996	772	56	2488	728	53	1592	424	27	2846	992
3							26	1976	542				23	2372	816			
Subject VII																		
1	28	1866	416	27	3686	1622				25	2954	702				51	4160	1308
2	52	2784	1194	50	3818	1492	53	2420	906	52	3702	1248	51	2666	776	26	3762	1198
3							24	3034	1460				26	2080	540			
Subject VIII																		
1	26	1938	532	25	3534	1178				26	2962	874				46	3374	950
2	53	2612	1136	45	4352	1276	58	2742	1128	52	3200	1276	46	2520	780	27	3752	1386
3							23	3186	1154				22	2996	804			
Subject IX																		
1	27	1834	848	24	2524	974				25	2398	794				56	3824	1550
2	49	2036	636	38	2658	1038	49	2866	1318	55	3664	1472	49	2958	1216	21	4690	1442
3							23	2804	820				24	3198	1278			
Subject X																		
1	23	1726	494	21	1708	476				24	1512	394				51	1878	410
2	48	1760	420	42	2100	694	51	1608	338	49	1870	422	50	1624	358	27	1938	332
3							25	1896	516				24	1784	410			
Subject XI																		
1	28	1636	522	20	2864	980				25	2704	1226				49	3240	1230
2	55	2132	840	50	3004	1296	52	2096	652	56	2954	1308	47	2176	808	27	3840	1384
3							24	2644	1482				26	2282	982			
Subject XII																		
1	25	1704	556	24	2584	1104				26	3050	1308				48	3128	1174
2	57	2410	872	51	4174	1398	53	2688	1078	56	3514	1190	45	2640	914	24	3320	1084
3							18	3176	976				19	3080	938			

TABLE 11

Distribution of reaction times, adjectives and nouns

SIGMA	SUBJECT V						SUBJECT VI					
	One syllable		Two syllables		Three syllables		One syllable		Two syllables		Three syllables	
	Adjectives	Nouns	Adjectives	Nouns	Adjectives	Nouns	Adjectives	Nouns	Adjectives	Nouns	Adjectives	Nouns
400	0	0	0	0	0	0	0	0	0	0	0	0
500	0	0	0	0	0	0	0	0	0	0	1	0
600	0	0	0	0	0	0	0	0	3	0	1	0
700	6	1	2	0	0	0	6	1	18	1	5	2
800	12	6	6	2	2	0	13	1	37	2	11	0
900	25	9	26	4	13	0	40	6	49	15	33	4
1000	42	13	52	16	31	1	34	14	50	19	32	16
1100	26	18	53	26	37	19	18	17	43	29	51	18
1200	18	17	43	41	45	21	17	19	27	19	37	24
1300	11	24	48	37	37	27	13	16	36	36	40	32
1400	13	13	33	40	32	25	11	22	19	22	27	30
1500	10	13	20	33	33	39	7	16	13	24	21	24
1600	5	11	15	18	12	46	3	9	10	29	14	25
1700	2	11	10	29	18	26	2	12	8	22	17	22
1800	2	5	6	25	16	22	6	7	7	16	8	18
1900	4	9	8	15	8	16	0	6	8	10	12	19
2000	2	6	6	8	12	13	3	5	3	15	5	19
2100	0	4	5	10	9	20	1	3	0	11	9	9
2200	0	3	3	9	5	16	1	5	7	6	3	11
2300	0	0	2	5	8	11	0	4	0	9	2	10
2400	0	1	1	1	5	8	0	2	2	5	3	7
2500	1	0	3	7	3	6	0	0	0	7	1	8
2600	0	2	1	2	2	7	1	2	5	3	1	3
2700	0	1	0	0	3	7	0	1	0	1	2	4
2800	0	1	0	4	3	1	0	1	2	7	4	8
2900	0	2	0	7	2	3	0	0	1	4	4	3
3000	0	0	1	1	2	0	0	1	1	5	1	8
3100	0	0	0	4	0	4	0	1	0	3	1	4
3200	0	0	1	1	2	3	0	2	1	0	0	1
3300	0	1	1	2	0	3	0	2	0	2	2	6
3400	0	1	0	1	1	0	0	0	0	3	0	2
3500	0	1	0	0	1	1	0	0	0	3	0	2
3600	0	0	0	1	0	0	0	0	0	1	2	1
3700	0	0	0	0	0	0	0	0	0	4	0	0
3800	0	0	0	2	2	0	0	0	0	1	1	1
3900	0	0	0	0	1	1	0	0	0	0	0	1
4000 to 12,000	0	3	0	1	5	2	0	1	2	10	1	8
Total cases	179	176	347	352	350	348	176	176	351	344	352	350
Average R. T.	1196	1584	1382	1666	1616	1852	1196	1602	1290	1836	1466	1910
M. V.	236	418	278	408	450	424	356	386	358	598	414	580

TABLE 12

Distribution of reaction times, adjectives and nouns

SIGMA	SUBJECT VII						SUBJECT VIII					
	One syllable		Two syllables		Three syllables		One syllable		Two syllables		Three syllables	
	Adjectives	Nouns	Adjectives	Nouns	Adjectives	Nouns	Adjectives	Nouns	Adjectives	Nouns	Adjectives	Nouns
400	0	0	0	0	0	0	0	0	0	0	0	0
500	0	0	0	0	0	0	0	0	0	0	0	0
600	0	0	0	0	0	0	0	0	0	0	0	0
700	0	0	1	0	0	1	1	0	1	0	0	0
800	3	1	3	0	2	0	5	1	4	0	0	0
900	9	3	18	0	1	0	10	0	9	1	1	0
1000	13	2	21	2	14	0	17	1	16	1	6	0
1100	21	3	32	9	26	2	12	1	19	6	15	1
1200	15	9	29	12	21	3	12	5	29	8	11	1
1300	16	9	27	16	25	8	15	9	29	3	25	0
1400	16	8	22	10	23	13	7	8	23	11	20	7
1500	21	12	23	21	23	14	11	10	23	17	27	14
1600	3	15	13	17	17	10	9	6	18	13	24	15
1700	10	6	20	30	26	19	10	6	17	22	21	13
1800	7	8	17	12	20	13	11	7	24	15	13	16
1900	8	6	11	10	12	18	9	10	12	14	15	18
2000	6	13	11	13	8	24	6	9	13	16	16	7
2100	3	7	12	19	14	14	1	5	11	7	15	20
2200	1	11	11	12	9	11	6	9	14	15	12	16
2300	7	3	12	11	7	16	3	7	7	13	10	6
2400	1	4	6	8	6	13	1	7	4	11	8	17
2500	1	2	9	17	9	11	3	4	8	13	7	9
2600	2	5	4	8	13	16	2	10	5	15	7	16
2700	2	3	7	6	7	10	0	5	8	13	4	12
2800	1	4	5	7	9	8	1	6	3	8	8	11
2900	1	1	6	9	8	7	1	5	7	5	12	7
3000	1	4	3	4	6	9	2	7	7	7	9	14
3100	0	3	4	10	5	7	2	4	0	4	6	9
3200	0	2	3	8	2	5	3	2	0	8	3	7
3300	2	3	3	2	3	3	1	2	2	9	5	7
3400	2	3	1	3	2	6	1	1	2	7	2	13
3500	3	3	1	7	0	5	0	1	2	2	4	12
3600	0	3	2	1	3	4	1	2	3	7	4	4
3700	1	1	1	4	1	3	0	2	2	4	0	8
3800	0	2	1	6	2	5	0	3	1	2	0	5
3900	0	2	2	2	2	7	0	1	3	9	3	4
4000 to 12,000	1	16	9	50	25	59	5	13	15	48	30	58
Total cases	177	177	350	346	351	344	168	169	341	334	344	347
Average R. T.	1640	2380	1856	2660	2130	2902	1766	2434	1962	2752	2318	2978
M. V.	478	928	636	1014	758	1046	548	730	652	624	920	1042

TABLE 13

Distribution of reaction times, adjective and nouns

SIGMA	SUBJECT IX						SUBJECT X					
	One syllable		Two syllables		Three syllables		One syllable		Two syllables		Three syllables	
	Adjectives	Nouns	Adjectives	Nouns	Adjectives	Nouns	Adjectives	Nouns	Adjectives	Nouns	Adjectives	Nouns
400	0	0	0	0	0	0	0	0	0	0	0	0
500	0	0	0	0	0	0	0	0	0	0	0	0
600	0	0	0	0	0	0	0	0	0	0	0	0
700	3	0	1	0	0	0	2	1	0	0	0	0
800	9	1	4	0	0	0	7	2	5	0	1	0
900	12	5	15	2	3	0	20	8	16	1	4	0
1000	12	7	31	4	6	2	28	13	33	3	10	3
1100	15	14	43	6	16	2	25	9	39	11	21	6
1200	16	4	28	21	23	8	24	19	37	34	24	14
1300	12	15	28	24	29	18	15	20	36	40	45	23
1400	8	11	23	16	26	13	9	18	46	34	22	26
1500	10	12	19	20	23	14	10	18	26	42	30	32
1600	9	10	15	17	29	16	7	23	20	30	27	33
1700	4	9	26	20	20	16	6	12	10	30	19	35
1800	8	18	16	17	26	15	4	4	14	19	19	25
1900	8	8	10	16	15	20	5	7	13	21	16	22
2000	1	8	11	13	12	16	5	4	12	9	13	17
2100	4	6	13	12	13	14	0	1	13	8	15	25
2200	6	4	6	9	10	14	0	2	5	10	15	20
2300	3	6	12	16	10	21	1	6	8	13	10	11
2400	3	4	7	11	11	15	2	1	5	9	17	13
2500	3	3	6	10	5	7	1	3	0	4	8	6
2600	5	0	2	8	3	14	0	2	2	2	6	5
2700	3	3	3	10	6	12	1	0	2	4	2	5
2800	3	4	3	5	6	14	1	0	1	4	5	0
2900	4	4	5	10	7	14	0	0	1	2	4	5
3000	1	1	4	6	5	9	0	0	1	2	6	5
3100	3	0	1	8	3	4	0	0	1	0	1	1
3200	0	1	0	4	3	11	0	0	1	0	0	2
3300	2	4	2	7	4	4	0	0	0	0	0	1
3400	1	2	3	4	4	1	0	0	1	0	0	3
3500	0	1	3	8	6	2	0	0	0	1	1	0
3600	3	0	1	3	1	2	0	0	0	0	0	0
3700	0	1	2	3	2	4	0	0	0	1	2	0
3800	0	0	1	1	3	5	0	0	0	0	0	0
3900	0	1	2	2	0	2	0	1	0	0	1	1
4000 to 12,000	3	5	10	24	11	40	0	0	1	0	0	1
Total cases	174	172	347	337	340	349	173	174	349	334	344	340
Average R. T.	1738	1918	1830	2338	2022	2568	1338	1532	1508	1714	1790	1958
M. V.	634	586	604	804	612	814	300	294	240	346	546	358

TABLE 14

Distribution of reaction times, adjectives and nouns

SIGMA	SUBJECT XI						SUBJECT XII					
	One syllable		Two syllables		Three syllables		One syllable		Two syllables		Three syllables	
	Adjectives	Nouns	Adjectives	Nouns	Adjectives	Nouns	Adjectives	Nouns	Adjectives	Nouns	Adjectives	Nouns
400	0	0	0	0	0	0	0	0	0	0	0	0
500	0	0	0	0	0	0	0	0	0	0	0	0
600	0	0	0	0	0	0	1	0	0	0	0	0
700	2	0	0	0	1	1	2	0	2	0	0	0
800	5	0	9	0	1	0	4	3	4	0	3	1
900	13	1	19	2	8	1	7	4	10	4	7	2
1000	17	5	24	5	16	5	13	4	25	8	5	4
1100	21	9	39	9	24	1	14	9	27	13	13	6
1200	25	13	31	15	22	9	11	10	17	16	16	10
1300	14	13	28	22	23	13	16	12	23	18	16	11
1400	11	13	21	19	19	11	15	13	24	16	11	19
1500	5	14	19	19	15	15	3	9	22	12	17	13
1600	8	8	11	23	16	17	11	9	19	19	11	10
1700	9	6	13	16	17	22	11	14	15	20	17	17
1800	3	8	10	12	10	18	7	7	12	19	17	23
1900	3	3	13	8	15	12	5	8	17	6	23	14
2000	0	3	7	10	12	8	8	12	9	21	9	12
2100	2	11	9	16	10	16	8	9	16	10	12	15
2200	5	6	12	10	10	17	8	4	7	14	13	13
2300	2	7	11	7	12	17	5	9	9	16	11	20
2400	0	7	4	5	8	11	1	0	8	7	12	16
2500	0	3	2	5	6	7	1	3	10	14	11	14
2600	4	7	1	9	6	7	4	3	4	8	9	8
2700	3	3	5	8	8	7	4	2	9	6	8	9
2800	2	5	8	6	2	5	1	5	7	9	11	8
2900	0	0	3	9	1	4	1	2	3	7	8	10
3000	2	1	3	7	8	4	3	1	3	8	9	10
3100	2	1	6	5	2	8	1	3	6	10	9	8
3200	4	5	5	6	2	7	2	1	2	5	1	8
3300	1	1	3	4	2	4	0	1	2	5	6	8
3400	1	3	0	4	2	6	0	1	3	4	4	6
3500	1	3	1	4	3	7	1	1	2	3	1	3
3600	1	1	5	3	1	3	0	1	2	10	3	4
3700	2	1	2	6	1	4	0	2	3	3	3	6
3800	1	2	3	5	4	0	1	0	3	3	5	0
3900	0	0	0	5	3	4	0	1	0	1	1	2
4000 to 12,000	5	14	23	64	42	68	3	3	18	29	30	34
Total cases	174	177	350	348	332	339	172	166	343	344	332	344
Average R. T.	1694	2300	1998	2860	2396	3002	1736	1920	2038	2336	2460	2518
M. V.	676	886	812	1286	1078	1334	622	562	710	798	810	840

3. Failure of the subject to speak into the voice key so as to make the clock stop.

4. A few cases where 3 occurred for the experimenter.

These results corroborate the conclusions drawn from the averages. It will be noticed that to a great extent the modes bear out the same conclusions as do the averages, especially for the increase in reaction time for nouns over adjectives.

The relatively large number of reaction times of four seconds and over, for some of the subjects, must indicate either that the stimulus words need further elimination or that these subjects had particularly slow reaction times, therefore bringing a larger percentage of reactions into this four second group. Both conclusions are true to some extent. Some further elimination is still necessary to accommodate the lists to the vocabularies of even university freshmen. On the other hand subjects VII, VIII, and XI were naturally slow in reaction no matter how simple the stimulus word.

Conclusions for experiment II

1. The reaction time for the noun-adjective association is longer than for the adjective-noun association.

2. The reaction time for both adjective and noun stimulus words increases directly with the number of syllables in the stimulus word.

3. The above conclusions agree with those made in experiment I. They hold also for a group of difficult adjectives and nouns such as were used in the practise period of this experiment, although the reaction times in this case are greatly increased above those obtained on the large mixed group used in experiment I or the selected group of this experiment.

4. Distribution curves plotted from the results for adjective and noun stimulus words indicate that the modes for the reaction times follow in general the laws of the averages.

EXPERIMENT III

This experiment was carried out in its present brief scope merely to get some indication of the probable course of the experiment on a large scale. It consisted in repeating for two successive days the identical lists of day 10 of the regular series. The purpose was to see the course of the reaction time. For this reason the subject was not told that these lists were repetitions, but merely that he might possibly recognize some words as having been given before, to take no note of this but to react as usual with the first adjective or noun thought of, and to make no effort to duplicate his response for the same stimulus word. This work was done immediately at the close of the regular ten days' work by the same eight subjects.

Results for experiment III

The results are shown in table 15. On the whole there is a decrease in reaction time with each repetition of the same stimulus words, both adjectives and nouns. Subject V, however, did not conform to this type of reaction except in two out of a possible eight drops in reaction time. Unfortunately we have no note of any unusual behavior during these three days that might account for his eccentricity. If we exclude his results entirely the exceptions are few, only 1 increase as against 27 decreases for nouns and only 5 increases as against 23 decreases in reaction time for adjectives.

The response words given were usually repetitions in spite of the fact that most of the subjects did not recognize on the second day that the words were duplicates of those of the previous day, and in spite of the instructions given them in regard to recognizing a duplicate word. The subjects all "caught on" by the third day that the lists were duplicates; if one of them gave a new response word he usually commented on the fact to himself.

TABLE 15

Reaction times for repetitions of day 10

SUBJECT	TWO SYLLABLE ADJECTIVES									THREE SYLLABLE ADJECTIVES								
	Day 10			Day 11			Day 12			Day 10			Day 11			Dax 12		
	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.
V	29	1400	266	29	1630	414	30	1458	220	60	1674	432	58	1932	380	59	1638	208
VI	30	1066	184	29	954	122	30	994	170	60	1436	362	59	1200	292	60	1214	248
VII	29	1884	520	29	1318	290	29	1166	266	58	2154	754	56	1666	504	59	1356	432
VIII	30	1350	318	29	1604	402	30	1172	312	59	2044	658	59	1848	652	59	1488	420
IX	30	1562	504	30	1570	408	30	1372	314	56	1776	398	59	1566	416	60	1678	476
X	30	1644	368	26	1398	174	30	1120	156	55	1956	516	59	1376	264	60	1228	230
XI	29	1930	910	30	1758	446	29	1310	400	56	2732	1356	58	2260	806	57	1758	716
XII	30	1760	676	30	1348	546	30	1040	346	59	2086	708	60	1680	692	60	1328	462
	TWO SYLLABLE NOUNS									THREE SYLLABLE NOUNS								
V	30	1758	346	30	2210	502	30	1878	426	59	2046	484	59	2200	380	60	2072	364
VI	30	1708	482	30	1198	216	30	1108	140	59	1916	592	57	1500	408	58	1438	358
VII	29	2688	996	29	1922	746	28	1366	332	55	2902	1226	55	2024	688	57	1610	488
VIII	30	2374	714	30	2262	802	29	1808	556	57	3106	1032	60	2582	810	57	2124	702
IX	30	2210	840	29	1848	484	30	1536	360	58	2518	736	57	2162	824	60	2088	688
X	28	1946	360	27	1512	298	30	1198	218	55	2146	542	59	1470	252	58	1204	174
XI	30	3698	1842	30	2806	1226	30	1858	612	53	3214	1320	54	3224	1364	58	2120	850
XII	30	1998	738	30	1628	550	30	1154	360	58	2098	566	53	1784	612	60	1540	418

Conclusion for experiment III

1. Successive repetitions of a list of stimulus words cause successive decreases in the reaction times when the subject is not informed of the fact of repetition. These reaction times would ultimately reach a physiological level.

EXPERIMENT IV. DOUBLE ASSOCIATIONS

This experiment like experiment III was made only on a small scale in order to get an indication of the probable course of the results on a larger scale. It comprised one hour's work only for each of four subjects, V, VI, VII, VIII. Six lists of stimulus words were given, 20 each of one, two and three syllable adjectives and intransitive verbs, run in parallel as in experiment II.

Double associations were required. For an adjective stimulus word, the subject must think of a noun applicable to the adjective and respond orally with a verb having this noun as subject. In this way the first association was silent, the second spoken. The verb given might be either transitive or intransitive, but auxiliaries were prohibited. With the transitive verbs, the association was made in the reverse order, back to a noun as its subject (silent) and then to an adjective (spoken) modifying this noun. Intransitive verbs were chosen for this type of reaction as a check on the backward direction of the association, otherwise the association might be made forward to an object of the verb and its modifier.

Results for experiment IV

The results are shown in table 16. With the two exceptions in the three syllable words, there is a uniformly large reaction time

TABLE 16

Reaction times for double associations

SUBJECT	ONE SYLLABLE						TWO SYLLABLE						THREE SYLLABLE					
	Adjectives			Verbs			Adjectives			Verbs			Adjectives			Verbs		
	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.	Cases	Av.	M. V.
V	20	2236	696	20	2466	618	20	2466	466	20	2498	546	19	3054	496	20	2892	680
VI	19	1740	400	20	2576	556	19	2458	762	20	2958	852	20	2428	668	20	2658	516
VII	20	2844	764	18	3954	1496	19	4112	1008	20	4690	1674	20	4378	1720	20	5202	1492
VIII	20	2894	626	20	4206	1230	20	4546	1924	19	4606	1566	20	4382	1290	19	4256	1116

for the backward association from verbs to adjectives. This results agrees with the comments of the subjects when asked which was the easier. The backward association with some exceptions was felt to require the greater effort. The increase in reaction time varies, to be sure, between wide limits among the different subjects and for stimulus words of different lengths, from 32 sigma to 1312 sigma, with an average increase of 571 sigma. For the two exceptions for subjects V and VIII,

respectively, the decrease in reaction time for the backward association is small compared to the average increase for other cases. It amounts only to 162 sigma and 126 sigma. A larger number of cases would probably throw these results in the same direction as the others.

Conclusion for experiment IV

1. The reaction time is longer for "backward" than for "forward" double associations, using these terms to refer to the normal language order. The reaction time is longer in associating from intransitive verbs back through noun subjects to modifying adjectives than from adjectives forward through noun subjects to verbs.

SUMMARY

One of the most important results of this investigation has been the preparation of lists of stimulus words suitable for use in the word association reaction. These lists total 10,888 words and are classified into groups of adjectives, nouns, transitive verbs, and intransitive verbs, each list arranged in chance order alphabetically and further subdivided into groups of one, two, and three syllables. Furthermore each of these groups has been once tested for the suitability of its words to the word association reaction and separated into selected words, rejected words, homonyms. It is insisted that this evaluation of the stimulus words can by no means be considered final or of universal fitness, but will surely serve greatly in a proper selection of words for a particular purpose in view.

The complete lists without eliminations were used once with four subjects to study the adjective-noun, noun-adjective, verb-object and verb-subject controlled associations, and to obtain data for the selection and rejection of words.

The adjective-noun and noun-adjective controlled association was more intensively studied on eight new subjects using 1800 words from the revised lists, keeping the number of stimulus nouns and adjectives equal, and constant for all subjects at each

of the ten sessions, and preserving an exact balance in the order of presentation of the various groups. In both parts of the experiment the associations were recorded, also the reaction times, which were measured with the Johns Hopkins chronoscope. Averages and mean variations were calculated on the Burroughs adding machine, using the Dunlap adding machine formula for the mean variations. From this data it was purposed to observe whether there is any definite time relation between the adjective-noun and the noun-adjective associations, or between the verb-object and verb-subject association and whether the reaction time has any fixed relation to the number of syllables in the stimulus word, the position of the accent or the logical category to which the stimulus word belongs. Some data was secured on double associations and associations to repeated stimulus words, and the emotional adaptation of the subject to the experiment is discussed.

The following conclusions were drawn from the results:

1. The normal order for adjectives and nouns in the English language gives on the average a shorter association time than the inverse order, when the number of syllables in the compared groups is the same. That is, the reaction time for the adjective-noun association is shorter than for the the noun-adjective association. This holds when the groups are made up of carefully selected words, or when the stimulus words are all difficult, i.e., the words rejected from the revised lists, or when the stimulus words are still unevaluated and therefore include both difficult and easy words.

2. The reaction time for both the adjective-noun and noun-adjective associations increases on the average directly with the number of syllables in the stimulus word, and as in (1) holds for carefully selected stimulus words, or difficult words, or mixed groups of words containing both selected and difficult words.

3. The position of the accent in the stimulus word has no systematic effect on the reaction time for either the adjective-noun or noun-adjective association.

4. There is no interpretable variation in reaction time on the average according to the grouping of stimulus nouns into

logical categories. The reaction time remains relatively constant within the limits of word length when large groups of stimulus words are used.

5. The reaction time for the verb-subject association is longer on the average than for the verb-object association for stimulus words having the same number of syllables. As with the nouns and adjectives the normal order for the English language gives the shorter reaction time.

6. For both the verb-subject and verb-object associations the reaction time on the average increases directly with the number of syllables in the stimulus word.

7. Two or three separate hours of work are sufficient for the subject to become adapted to the procedure of the word association experiment, and to lose as much as is possible of any emotional disturbance resulting from the novelty of his environment or from sex difference between subject and experimenter.

8. The begining of each list of words is usually marked by three or four reaction times faster than the average. There is then a sudden increase which persists throughout the list, and which may be due to the adjustment of the subject to a comfortable steady muscular "tension" adapted to a long period of work.

9. Successive repetitions of a list of stimulus words for both the adjective-noun and the noun-adjective associations, cause successive decreases in the reaction time when the subject is not informed that the stimulus words are words that have been given before. These reaction times would no doubt ultimately reach a physiological level.

10. The reaction time for double associations is longer on the average for the inverse order than for the normal order in the English language. That is, the reaction time is longer in associating from intransitive verbs backward through noun subjects to adjectives than forward from adjectives through noun subjects to verbs.

11. In all controlled word association experiments, any interpretation of reaction times must surely take into consideration the type of control put upon the associations, and the

number of syllables in the stimulus word. It is further insisted that conclusions are valid only when drawn from extended data using large groups of words as have been used in this investigation.

FURTHER TECHNICAL PROBLEMS IN THE WORD ASSOCIATION METHOD

In connection with the application of the Association Method to practical problems, and for the further understanding of the associative processes and conditions themselves, a considerable number of special points remain to be investigated. Obviously, the accurate use of the association-reaction as a tool for the investigation of mental conditions demands the fullest possible knowledge of the laws of the reaction itself. The problems included in the following list have been formulated in this laboratory for experimental attack, and it is hoped that work on some of them may be under way before long.

1. A more detailed study of the course of the reaction time for repetitions of a group of stimulus words of different types, as suggested in Experiment III.
2. A more detailed study of double and triple associations along the line suggested in Experiment IV.
3. The effect of suggestion on the reaction time variation for different types of forward and backward controlled associations.
4. Comparison of visual and auditory methods of presentation of stimulus words in the word association method.
5. A comparison of spoken and written types of reaction in the word association method.
6. The variation in reaction time for the adjective-noun and noun-adjective reaction in French, Italian, and Spanish subjects.
7. A study of the emotions in the word association method, when supplemented by plethysmographic, cardiographic, sphygmographic, pneumographic, and galvanometric controls.
8. Sex differences in various types of controlled word associations.
9. Investigation into the comparative length of reaction times for the following types of controlled word associations;
   (1) noun subject—intransitive verb
   noun subject—transitive verb
   noun subject—verb (either v.i. or v.t.)

(2) intransitive verb—noun subject
transitive verb—noun subject
verb (either v.i or v.t)—noun subject
(3) transitive verb—noun object
nouns object—transitive verb
(4) noun subject—verb
verb—noun subject
(5) Comparison of English and German subjects for (3) and (4).
(6) noun subject—(verb)—noun object
noun object—(verb)—noun subject
(7) noun (cause)—verb (effect)
verb (effect)—noun (cause)
(8) verb—adverb
adverb—verb
(9) class (genus)—member (species)
member (species)—class (genus)
(10) opposites for verbs
(11) opposites for adjectives
(12) opposites for adverbs
(13) coordinate members.

10. A study of preferential associations.
(1) to observe whether transitive or intransitive verbs occur more often in the *noun subject—verb* reaction.
(2) to observe whether noun subjects or noun objects occur more often in the *verb—related noun* reaction
(3) to observe whether noun subjects or noun objects occur more often in the *noun—noun (related through action)* reaction
(4) to observe which type of reaction occurs more often in the *noun—logically related word (other than verb)* reaction; adjective, subordinate, supraordinate, or co-ordinate.
(5) to observe which type of reaction occurs more often in the *adjective—logically related word* reaction; substantive or opposite.

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